THURSDAY, FEBRUARY 18, 1886

PRACTICAL BACTERIOLOGY

An Introduction to Practical Bacteriology, based upon the Methods of Koch. By Edgar M. Crookshank, M.B. (Lond.), F.R.M.S., Demonstrator of Physiology, King's College, London. (London: H. K. Lewis, 1886.)

THIS excellent work is based upon notes made in different Continental laboratories, and is intended to be a laboratory hand-book as well as a text-book of bacteriology, including as it does "a systematic sketch of the genera and species of micro-organisms, as well as the methods employed in the investigation of their life-histories." The science is intimately connected with the etiology of the infectious and contagious diseases, and by enlarging knowledge as to the origin, causes, and spread of these diseases, has greatly aided, and may be expected in the future greatly more to aid, in the acquisition of knowledge as to the measures necessary to be adopted for their prevention; nevertheless it has received attention in this country from but a few earnest inquirers, the great mass of information now at our disposal having been accumulated in Germany. This fact is apparent at once on glancing through the pages of this book; for every English work, six German at least are referred to as having been consulted by the author. Apart also from its association with medical pathology, the subject is of the greatest interest to the naturalist, be he botanist or zoologist. It is only necessary to refer to the work of Pasteur in this connection for a proof of the vast amount of benefit to commerce and science which may still be anticipated to arise from a fuller knowledge of the life-histories of those organisms which are associated with so many diseases of plants, animals, and men. The importance of a study, not merely of the pathogenic or disease-producing, but of all the different species of Bacteria and Fungi is fully grasped by the author in the following paragraph: "It is impossible, by localising one's knowledge to pathogenic species to thoroughly understand the life-history of these particular forms, or to be able to grasp and appreciate the various arguments and questions that arise in comparing their life-history with the progress of disease."

The postulates formulated by Koch for establishing the exact relationship, and ascertaining beyond question whether a micro-organism associated with disease is actually the cause of that disease, are quoted by the author in the introductory chapter, and bearing as they do so intimately on the controversies which have raged over the relations of micro-organisms to disease, especially of Koch's comma-bacilli to Asiatic cholera, may be given here. They are as follows:—(*a*) The micro-organism must be found in the blood, lymph, or diseased tissues of man, or animal, suffering from, or dead of, the disease. (*b*) The micro-organisms must be isolated from the blood, lymph, or tissues, and cultivated in suitable media, *i.e.* outside the animal body. These *pure cultivations* must be carried on through successive generations of the organism. (*c*) A pure cultivation thus obtained must, when introduced into the body of a healthy animal, produce the disease in question. (*d*) Lastly, in the inoculated animal the same micro-organism must again be found.

The first part of the work is devoted to a description of the "apparatus, material, and reagents employed in a bacteriological laboratory"; to the methods employed for the "microscopical examination of Bacteria in liquids, in cultivations on solid media, and in tissues"; to the "preparation and staining of tissue sections"; to the "preparation of nutrient media and methods of cultivation"; to the subject of "experiments upon living animals"; and to the method of "examination of animals experimented upon, and the methods of isolating micro-organisms from the living and dead subject."

The multiplicity and complexity of the apparatus, materials, and reagents required for this work, and the great care and nicety in manipulation necessary for its proper execution, may well dismay the scientific inquirer who wishes to make a practical study of the subject. The expense alone of fitting up a laboratory on the lines indicated by our author, must form a great obstacle in the path of the would-be student. The license to experiment upon animals which would be necessary for a thoroughly systematic investigation is, as is now well known, most difficult to obtain. And yet there is no laboratory in this country at which such investigations could be undertaken by any one at a moderate expense. Surely London is rich enough, and earnest enough in the cause of sanitary progress, to found an establishment on the model of the Hygienic Laboratory at Berlin. There is fortunately no lack of men, thoroughly capable of undertaking its supervision, and its popularity and usefulnesy would not be a matter of doubt to those who are acquainted with the work of the Biological Laboratory at the Health Exhibition of 1884.

Part II. is "systematic and descriptive, with special microscopical methods," and commences with the history of our knowledge of Bacteria, the difficult question of classification being also here dealt with. In 1872 Cohn published his first classification. He considered the Bacteria to be a distinct group belonging to the Algæ, but from the absence of chlorophyll allied to the Fungi, and divided them into four tribes according to their shape, as globules, short rods, long rods, and spirals, these four tribes including six genera. In 1875 Cohn, in answer to Billroth, who disputed the division into species, considering that all the forms described by Cohn were but developmental forms of one organism, *Coccobacteria septica*, propounded a second classification, in which he still maintained that distinct genera and species existed. The genera Cohn considered to be distinguished by definite differences in shape, which were adhered to throughout life, while some special feature, as a difference in size or physiological action, or some minute difference in form, determined the various species. "Researches," writes our author, "by competent observers have quite recently clearly demonstrated that several micro-organisms in their life-cycle exhibit successively the shapes characteristic of the orders of Cohn. This had as early as 1873 been observed by Lister in a Bacterium in milk. Lister detected forms of Cocci, Bacteria, Bacilli, and Streptothrix genetically connected." Recent observers also have obtained similar results, so that the very foundation of Cohn's classification has been shaken, and "we are left

without possessing a sound basis for classification into genera or species. The mode of reproduction is not sufficiently known to afford a better means for distinction than the other morphological appearances taken alone; nor can we depend upon physiological action, which is held by many to vary with the change of form according to altered surroundings." We have the authority, however, of Koch and Klein for believing that a Bacillus cannot change its nature, and be converted from a harmless into a pathogenic form, as asserted by Büchner.

It is usual now to regard Bacteria, yeasts, and moulds as constituting a class, the *Achlorophyllous Thallophytes*, divided into three orders: (1) *Schizomycetes* (Bacteria or fission-fungi); (2) *Saccharomycetes* (yeast-fungi); (3) *Hyphomycetes* (mould-fungi). Zopf, who, we learn, has warmly supported the pleomorphism of Bacteria, has suggested, as a result of his investigations, a division of the *Schizomycetes* into the following four groups: (1) *Coccaceæ*; (2) *Bacteriaceæ*; (3) *Leptothricheæ*; (4) *Cladothricheæ*. This classification is adopted by the author, but only as a provisional arrangement, pending increase in knowledge. "In determining," he writes, "the distinctions into species, we must take into account, not only microscopical appearances of the micro-organisms themselves, and their physiological actions, but the character of their colonies in plate cultivations, under a low power of the microscope, and the macroscopical appearances displayed in the various nutrient media. In this way, by considering each individual characteristic, Koch showed that the comma-bacillus of Finkler was a different organism from the Bacillus which was present in Asiatic cholera."

Group I., the *Coccaceæ*, are divided into five genera. Genus 1, *Streptococcus* (chain-cocci), includes the cocci found singly or in chains in acute abscesses; the cocci occurring in chains in the lymphatic channels of human erysipelatous skin, and in the fluid of erysipelatous bullæ, which produce typical erysipelas when re-inoculated in man and animals; cocci found in diphtheritic membranes and the surrounding tissues, and described as characteristic of this disease (but a Bacillus and a Bacterium have also been described as the specific micro-organisms of diphtheria); cocci of vaccine lymph, of which they are regarded as the active principle, since filtration deprives the latter of its infectious element, and successful vaccination has been stated to result from artificial cultivations. Numerous other forms are also included in this genus. Genus 2, *Merismopedia* (plate-cocci), includes *Coccus gonorrhææ* and *Micrococcus tetragonus*, pathogenic to mice. Genus 3, *Sarcina* (packet-cocci), includes *Sarcina ventriculi*, a coccus occurring in the stomach of man and animals; *Sarcina lutea*, a non-pathogenic form; and some other forms. Genus 4, *Micrococcus* (mass-cocci), includes the coccus of yellow pus, which is also the specific organism of acute infectious osteo-myelitis, a destructive disease of the marrow of bones; the coccus of blue pus; the coccus of fowl-cholera; *Micrococcus prodigiosus*, a harmless organism which produces a blood-red colour when cultivated on potatoes; the micrococcus of septicæmia and that of pyæmia in rabbits, and numerous other forms. Genus 5, *Ascococcus* (pellicle-cocci), only one form known.

Group II., *Bacteriaceæ*, is divided into six genera. Genus 1, *Bacterium* (cocci and rods, or only rods, which are joined together to form threads; spore-formation absent or unknown), includes the *Bacterium aceti* which causes the conversion of alcohol into vinegar; the bacterium of croupous pneumonia, occurring in pneumonic exudations, which by inoculation can produce the disease in mice. Genus 2, *Spirillum* (threads screw-form, made up of rods, or of rods and cocci; spore-formation absent or unknown). In this genus is contained the spirillum of Asiatic cholera—curved rods or commas, spirilla, and threads. The commas occur isolated or attached to each other, forming S-shaped organisms or longer screw-forms, and are found in the superficial necrosed layer of the intestines, in the mucous flakes and liquid contents of the intestinal canal of cases of Asiatic cholera. They were also detected by Koch in India in a tank used to supply drinking-water. Their development is arrested by deprivation of air, and they are destroyed by drying and various antiseptics. The results of their injection into the duodenums of guinea-pigs, said to have produced choleraic symptoms, have been by others asserted to have been due to septicæmic poisoning. The difference in appearance produced by pure cultivations in gelatine-peptone broth of Finkler's comma-bacillus and Koch's cholera-bacillus are very well illustrated, and the differences in growth of these two spirilla in other media carefully described. Finkler's bacillus or spirillum has been discovered in the evacuations of cases of cholera nostras, and has been shown quite recently to be also pathogenic. In this genus is also contained the spirillum of relapsing fever, observed in the blood of patients suffering from relapsing fever, but present only during the relapses. Monkeys have been successfully inoculated from cases of the disease in man. Genus 3, *Leuconostoc* (cocci and rods; spore-formation present in cocci), contains the frog-spawn fungus, which occurs occasionally in beet-root juice, and the molasses of sugar-makers, forming large gelatinous masses resembling frog-spawn. "The vegetation is so rapid that 49 hectolitres of molasses, containing 10 per cent. of sugar, were converted within twelve hours into a gelatinous mass; consequently it is a formidable enemy to the sugar manufacturers." Genus 4, *Bacillus* (cocci and rods, or rods only, forming straight or twisted threads; spore-formation present either in rods or cocci), includes *Bacillus subtilis*, the hay-bacillus, occurring widely in air, water, and soil; *Bacillus anthracis*, or bacillus of splenic fever in cattle, and of woolsorter's disease or malignant pustule in man, of which a very full and descriptive account is given, its morphological and biological characteristics having been very completely worked out. This disease, anthrax, is one of those in which Pasteur has succeeded in attenuating the virus so as to produce a "vaccin" capable of conferring immunity on animals after inoculation. The *Bacillus tuberculosis* also belongs to this genus. The numerous methods of preparing and staining the bacilli are fully described. The bacillus of blue milk, the bacillus of malignant œdema in mice, and that of septicæmia in mice, the bacillus of typhoid fever, observed in inflamed Peyer's glands, in the spleen, mesenteric glands, and the lungs in fatal cases of typhoid fever, but not as yet imparted to animals by inoculation, the bacillus of leprosy, the bacillus of malaria, the bacillus of glanders, and some others,

complete a class of micro-organisms of the greatest importance from the number of pathogenic forms it contains. Genus 5 is the *Vibrio* of ordinary putrefaction; screw-form threads in long or short links; spore-formation present. Genus 6, *Clostridium* (same as bacillus, but spore-formation takes place in characteristically enlarged rods). In this genus are the bacillus of butyric acid fermentation, which converts the lactic acid of milk into butyric acid, and produces the ripening of cheese, and the clostridium of symptomatic anthrax, the cause of "black-leg" or "quarter-evil" in cattle.

Group III., *Leptothricheæ*, contains the following genera: (1) *Crenothrix* (threads articulated, cells sulphurless, habitat water), occurring in wells and drain-pipes. (2) *Beggiatoa* (threads unarticulated, cells with sulphur-granules, habitat water), of which the best-known is *Beggiatoa alba*, or the "sewage fungus," found in sulphur-springs and marshes, as well as in sewage-polluted streams. (3) *Phragmidiothrix* (threads jointless, successive subdivision of cells is continuous, cells sulphurless, habitat water), found attached to crabs in sea-water. (4) *Leptothrix* (threads articulated or unarticulated, successive subdivision of cells not continuous, cells sulphurless), found in carious teeth.

Group IV., *Cladothricheæ* (possessing cocci, rods, threads, and spirals: thread-forms provided with false branchings), contains *Cladothrix dichotoma*, said to be the commonest of all Bacteria in both still and running water, in which organic substances are present.

Amongst species of Schizomycetes mentioned by writers, and not described or not recognised as distinct species in the preceding classification, are *Micrococcus indicus*, *Micrococcus septicus*, *Micrococcus endocarditicus*. The micrococci of measles, scarlatina, cerebro-spinal meningitis, typhus, acute yellow atrophy of the liver, whooping-cough, puerperal fever, gangrene, yellow fever, dental caries, and saliva. Most of these organisms are only known to be associated with the diseases in question, the causal relations, if existent, have yet to be determined. In this chapter are also described *Bacterium termo* of common putrefaction, *Bacterium lactis*, *Bacillus figurans*, the bacillus of swine fever, the bacillus of choleraic diarrhœa from meat-poisoning, the bacilli of septicæmia in man, of syphilis, and of rhinoscleroma, the comma-bacillus of the mouth, various forms of spirillum and monas, *Proteus vulgaris*, described as intimately connected with the process of putrefaction, *Actinomycetes*, said to be the cause of actinomycosis, a disease of the jaws and lungs in men and animals, and many others too numerous to mention.

An appendix is devoted to the consideration of the yeast-fungi, or *Saccharomycetes*, and of the mould-fungi, or *Hyphomycetes*; under the latter are described the various species of *Mucor*, *Oidium*, *Aspergillus*, &c. The volume concludes with an account of Koch's methods for the examination of air, water, and soil, with a view to the detection and recognition of their contained micro-organisms.

Enough has probably been said to show the wide range covered in this work and the full and able manner in which its matter has been treated. On the importance of the subject and the want that has been supplied by the production of a work that has condensed into one volume a subject, the literature of which in English is diffused in numerous reports and periodicals, we have already remarked. The numerous coloured plates of test-tube and potato cultivations and those of microscopic appearances are admirably designed and executed, and greatly enhance the value of the work.

The book, we believe, will be widely read and appreciated by all interested in science.

THE ANATOMY OF THE NETTLE

*Recherches anatomiques sur les Organes végétatifs de l'*Urtica dioica, *L.* By A. Gravis. (Brussels, 1885.)

A WORK of more than 250 pages devoted exclusively to the anatomy of the vegetative organs in one species of nettle is a publication of a somewhat unusual kind, even in these days of scientific specialisation. The author has evidently bestowed a vast amount of labour on his subject. He states in his introduction that no less than 15,000 sections had to be made in the course of his investigation of this one plant, and twenty-three beautifully executed plates bear witness to the laborious accuracy with which the work has been carried out. The treatise is one which hardly admits of an abstract, as in a monograph of this kind details are everything. We shall only attempt to give a sketch of the order in which the author has arranged his facts, and to indicate one or two points on which his conclusions have some general interest.

The investigation was originally intended to serve as a basis for a general comparative study of the family Urticaceæ. The question of the value of anatomical characters in classification is one which has engaged the attention of many botanists during the last few years. So far the results have proved of very unequal importance in different cases. The author notices the much more considerable part played by anatomy in zoological than in botanical classifications. This he attributes in a great degree to the frequent neglect on the part of botanists to examine every part of the plant in question, at all ages, and under varying biological conditions. Too often one or two sections are made, almost at haphazard, from each species, with the result that things not truly comparable are frequently compared. One of the main objects of the work before us is to show how great the variations are which are due to the differences just mentioned.

The treatise is divided into three parts, devoted respectively to the stem, the leaf, and the root. The first part begins with a general account of the external conformation of the stem of the nettle, and its systems of subaërial and subterranean branches. For the purposes of his exposition the author divides the stem into *segments*, each segment including a node, with the lower half of the internode next above it and the upper half of that next below it. He then proceeds to classify the variations of structure investigated. First he distinguishes variations *according to level*, by which he indicates the different structures shown by transverse sections of different parts of the *same* segment, the most important of these differences being those between the nodal and internodal structure. Next come variations *according to age*, namely, those which are presented by corresponding sections taken at different periods of development. The third

class of variations are those *according to height*, that is to say, those shown by corresponding sections of *different* segments of the stem. Fourthly, and lastly, we have variations *according to the biological conditions*.

The first chapter contains a detailed account of the structure of "segment 1" of the principal stem, *i.e.* the segment including the node next above the cotyledons. In the succeeding chapters the anatomy of the segments superior to segment 1, and the development of an apex of large diameter are treated of. The fourth chapter deals with the hypocotyledonary axis, under which term the radicle of the embryo is included.

The second part treats in a corresponding manner of the leaf, only here the cotyledons first receive attention, then the leaves next above them, and so on. The increasing complication of structure along the sub-aërial stems, and the converse degradation along those which are subterranean, form the subject of a special chapter.

In the third part the variations in the structure of the root according to age and height are considered, the subject of apical development having a chapter to itself.

The method of successive transverse sections was used throughout the investigation.

The author compares the constantly increasing complexity of the successive segments of the principal stem to an accelerated movement, the amount of the acceleration varying according to the biological conditions. This strikes us as a neat mode of expression.

The author's account of the progress of secondary thickening in the stem is interesting, especially the observation that in the lower segments cauline plates of vascular tissue of secondary origin occupy the same position as that assumed by additional primary bundles in the more complicated segments above them. This and similar facts lead the author to a generalisation which he expresses in a phraseology adapted from Haeckel's famous law, namely, that "the organogeny of the stem repeats its ontogeny."

We must enter a protest against the use of the word "cambiform" for cambium which gives rise to secondary fundamental tissue. The word cambiform has long been used for certain cells of the phloëm-parenchyma, and we already have quite ambiguities enough in the use of the word cambium and its derivatives.

The work concludes with the expression of the author's conviction that vegetable comparative anatomy demands a knowledge of the structure throughout the whole extent, and at all ages of the plant. A formidable task is thus imposed on the anatomists of the future. D. H. S.

OUR BOOK SHELF

Magnetism. By Willoughby Smith. (London: November, 1885.)

A PECULIAR pamphlet, said to be compiled for the instruction of the electrical staff of the Telegraph Construction and Maintenance Company, but issued gratis by the author, and devoid of any publisher. It commences with a novel version of the story of the shepherd of Mount Ida, who is given not only a local habitation, but a name, and it ends with a material notion of lines of force which will startle some of our readers. Moreover, electrical discharges, magnetic clicks, &c., are "caused by the lines of force adjusting themselves to each other." It contains nothing new of magnetism, but it promulgates some strange notions. "The Great Architect of the universe employs no rectilinear motions or angles." "Each atom of matter possesses in itself all the properties of a magnet, and emits its own lines of force." "All particles of matter, solid, liquid, or gaseous, are in a polarised state, and consequently emit lines of force." "The (electrical) conducting properties are the result of forced polarisation." "Each atom composing our atmosphere is in a state of polarisation, and is influenced by the magnetic force emanating from the earth." "The force which is called gravity is the effect of such an universal system of polarisation, with which God has endowed all matter." "Iron is very susceptible of polarisation from the effects of what is called terrestrial magnetism (the polarised atoms of the air)."

These extracts are enough to show the tenor of the paper, which will not enhance Mr. Smith's reputation. He has evidently not read Airy's "Treatise on Magnetism," where it is laid down that terrestrial magnetism is not produced in any important degree by magnetic forces external to the earth, and it does not even reside on the earth's surface. Its source must lie deep. The apparatus and experiment given at p. 29 are detailed more fully and clearly in Thompson's "Dynamo-Machinery," and that at p. 41 would be more elegantly obtained by Hughes's induction-balance. It is curious that no reference should be made to the labours of Sturgeon, Scoresby, W. Thomson, and Hughes, and that the laws of Lenz, Jacobi, Dub, Müller, and others are ignored. It is not a pamphlet on magnetism, but a vehicle for the promulgation of certain individual ideas, which it is to be hoped will not take root among those who have been favoured with the gift of this well-printed *brochure*. Indeed, its *raison d'être* is shrouded in mystery.

An Introduction to the Osteology of the Mammalia. By Wm. H. Flower, LL.D. Revised with the assistance of Hans Gadow, Ph.D. Third Edition. (London: Macmillan and Co., 1885.)

WHEN Prof. Flower published, in 1870, the first edition of his "Introduction to the Osteology of the Mammalia," the student at once recognised that he had been supplied with a text-book of convenient size and form, which furnished him with an admirable introduction to Mammalian osteology. The appearance of a second edition of this book in 1876, and of a third edition at the end of last year, are renewed evidence of the usefulness of the work, and that it continues to be appreciated by those who are engaged in the study of the anatomy of the Mammalia.

This edition has been revised throughout, and we notice in it many alterations and additions. The most important change is in the chapter "On the Classification of the Mammalia," which appropriately precedes the purely descriptive part of the book. This chapter has practically been rewritten, and embodies the introductory observations which the author has given to his important article "Mammalia," in the ninth edition of the "Encyclopædia Britannica." A very useful table has also been introduced in connection with the chapters on the vertebræ, which the author has compiled from his Catalogue of the Mammalia in the Museum of the Royal College of Surgeons of England. This table gives the number of the vertebræ situated in each region of the spine in the skeletons of about 350 mammals, and is the most complete record of the kind which has yet been prepared.

In this, as in the preceding editions, the dog's skull has been taken as that from which the general description of the Mammalian skull has been written, and with which the study of the skull may appropriately be commenced, and its description has not been changed; but in addition a useful abstract of our present knowledge of the development of the skull has been drawn up from Balfour's "Treatise on Comparative Embryology."

We have observed also a number of short but useful additions and emendations in the descriptions of various of the bones, so that the present edition exceeds the last by thirty-eight pages. The illustrations also have been increased by the insertion of eight more woodcuts. We wish to give a hearty recommendation to all students of the Mammalia, to use this new edition of a book, written by the anatomist who is admittedly one of the highest authorities on their structure.

Catalogue of the Fossil Mammalia in the British Museum. Part II. Artiodactyla. By Richard Lydekker, B.A. (London: Printed by order of the Trustees, 1885.)

MR. LYDEKKER published in January 1885 the first part of the Catalogue of Fossil Mammals in the British Museum, and in it he recorded the specimens belonging to the Orders Primates, Chiroptera, Insectivora, Carnivora, and Rodentia. He has rapidly followed this up by the preparation of the second part, containing the sub-order Artiodactyla of the great Order Ungulata. The Natural History Department of the British Museum is remarkably rich in specimens of this sub-order, and though in the Catalogue, in the larger number of instances, only the briefest possible description of each specimen is given, yet the volume has reached 324 octavo pages. The collections, in addition to those enumerated in the first part, which have furnished specimens, are the Bowerbank, Layton, Sloane, and Wigham collections. The author points out that he has employed generic terms in a wider sense than is the case with many writers. Thus he does not regard a difference of one or more premolar teeth, or in the number of digits, in allied forms, as a bar to generic unity, and accordingly he includes the genus *Eurytherium* in *Anoplotherium*. The Catalogue has been compiled with the care which distinguishes the catalogues of our great national Museum.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On "Seter," or Parallel Roads

I SEE to my great vexation that in my former letter on parallel roads (NATURE, January 21, p. 268) I have made a rather hideous blunder in my English to the great disadvantage of the clearness of my theory. I have used the French-German-Norwegian term "rest" as signifying *le reste.* My theory is that the last "rest," *i.e.* residue, of the inland ice formed a great dam somewhat seaward from the watershed; I do not refer to any "rests," *i.e.* reposes, in the great ablation.

It is a fact that the glacier-shed in Central Norway was situated as far as 150 kms. to the south or east of the watershed. The direction of the striæ and the boulder-transport renders this indisputable. By the melting of the ice I now suppose that the last remains must have lingered near the glacier-shed. We find the last residue far to the south of the watershed. I cannot find with Mr. Melvin that this idea reverses the order of Nature. The precipitation and temperature in Christiania and in Trondhjem now differ very inconsiderably, and the difference in height between the former glacier-shed and the watershed is not very great, while the distance from this to the sea is five times as great to the south as to the north.

This residue now in all valleys dams up lakes to the cols; in these lakes the terraces of gravel with laminated clay are built up; and on their shores the *seter* or parallel roads are formed. Nothing is simpler.

When I first got this conception I only knew the Österdal (and Lochaber) *seter*, but I concluded that parallel roads and inland terraces were to be expected in all valleys where the striæ proved that the glacier-shed lay seaward to the watershed. I next found some notice of such formations in the neighbouring valleys Gudbrandsdalen in Norway, and Herjedalen in Sweden. Having already finished my paper, I got a dissertation of Högbom in which, as expected, Jemtland was included in my *sete* region. In my letter to NATURE I further inferred that parallel roads must needs exist in Swedish Lappmark. This conclusion has also since proved to be correct. Dr. Svenonius has found a *sete* at Sitasjaur: the correlation of striæ going upwards against the drainage with terraces and parallel roads at a height corresponding with the cols. This is established between 61° 40′ and 68° in Scandinavia as well as at Lochaber. Nowhere else are parallel roads known in Europe. This local geographical distribution is perhaps the best argument for my theory of lakes dammed up by the gradually diminishing residue of the inland ice situated at a distance from the watershed, near the former glacier-shed.

Mr. Melvin's theory of lateral moraines was also my original working hypothesis; but it gives no explanation of the great terraces which are connected with the parallel roads, nor of the laminated clay (with Desmidieæ) in the terraces as well as in the *sete* itself. Any one who has walked for kilometres on a *sete*, smooth as a road, without any variation of the aneroid (the greatest difference in Lochaber is 4 metres), will hardly be able to dismiss the idea of a water-level. How Mr. Melvin will account for the alternating shelves *cut in the rock* I cannot see. ANDR. M. HANSEN

University Library, Christiania

P.S.—Errata in my former letter: p. 268, col. 2, line 11, for "280 kms." read "150 kms."; line 30 from bottom, for "till" read "tell."

Mimicry in a Neuropterous Insect

I HAVE been much struck by a somewhat complex form of mimicry in a neuropterous insect of the genus Mantispa, which would not be suspected if only a cabinet specimen were seen, with the wings extended motionless, with its raptorial fore-legs folded in front of the head. The insect, as I observed it, was on the bare whitewashed wall of a house at Delhi, exposed to the afternoon sun. As I then believed it to be a dipterous insect feeding on some substance stuck to the wall, it is probable that its prey, most likely the common house-fly, would be similarly deceived, and, being attracted to the spot in hopes of sharing the food, would fall a victim.

The prothorax is curiously modified, both in colour and shape, so as to resemble a proboscis, while the head and fore-legs are so compactly folded that they look like some solid substance adherent to the wall or stone on which the insect is resting, and not part of the creature itself. The mesothorax has two eye-like spots shaded so as to simulate the reflections of light from the compound eyes of an insect, while the markings of the abdomen, seen through the transparent wings, are very dipterous in character.

The points where the Mantispa seems to fail in its likeness to a fly are in the size of the prothorax, which is more massive and thick than the proboscis of any fly; there is a want of prominence in the mesothorax representing the fly's head; the venation of the wings is different; and, lastly, there are apparently only four legs instead of six.

These faulty points are seen at once on a minute inspection; but it may be imagined that it is only necessary to attract the attention of a fly passing at some distance, and convey a certain mental impression, which in the simple mind of a fly may not be effaced till the desired object has been attained, and the victim brought within reach of the Mantispa's arms.

The resemblance between the fore-legs of the praying Mantis and the same organs in Mantispa is remarkable when it is remembered that the two insects belong to different natural orders. The fore-leg of Mantispa is the more specialised, and has great lateral motion, while the edges of the femur are armed with teeth slightly blunt at the tips, so that the captured insect can be shifted if necessary. The joints in the same limb in the Mantis are simple hinges, and both the femur and tibia are fringed with a double row of very sharp spines, which are necessary to pierce and retain a hold on the thin unsubstantial wings

of a butterfly which the Mantis patiently waits for, perched on the top of some conspicuous head of flowers.

Simla, January 17 E. R. JOHNSON

Fabry's Comet

ON the 6th inst., with a power of 38 on a $4\frac{1}{4}$-inch refractor, I observed that this comet had a distinct, though very faint, tail, at a position-angle of about 85°; length $13\frac{1}{2}'$. The radius of the coma was about 3'. I thought I could see the tail on the 1st inst., but was not quite sure of it then. The comet's spectrum strikes me as less distinct than is the case with most comets. On the 1st inst. I could only see two bright lines (or bands) certainly; and the less refrangible of these was very faint. I suspected a third band towards the more refrangible end of the spectrum. T. W. BACKHOUSE

Sunderland, February 13

Mist-Bow

ON the Wiltshire Downs, near Marlborough, at about 4 o'clock on February 10, I observed a white mist-bow, in position and shape resembling the rainbow, but pure white, and the arc was of considerable width throughout, estimated at 5°–10°, altitude of the sun 15°–20°, altitude of the summit of the bow 35°–45°. The wind was slight, and there was a frost at the time, and a thick deposit of rime on the trees, &c. Has this been observed elsewhere or explained? Is the phenomenon due to the superposition of coloured bows, or to the polarisation of the semi-crystallised vapour composing the fog? A. E. E.

Movement of Telegraph-Wires

THERE can be no doubt that Mr. Mountford Deeley correctly attributes the rotatory oscillation of the wires during frost to the air-current acting upon a "wing" of ice-spicules. I described this phenomenon in *Science Gossip*, 1874, p. 254, and explained the cause of it in NATURE, vol. xxiii. p. 338.

Birstal Hill, Leicester F. T. MOTT

HENRY BRADSHAW

UNFORTUNATELY it far too often happens that there seems to be an impassable gulf fixed between the man of letters and the man of science, which hinders the one not only from partaking in, but even from appreciating, the ideas, the objects, and the methods of the other. There is no need, especially here, to impute blame to either; but when a man of letters is found who, modestly making not the least pretension to scientific knowledge, yet sympathises deeply with the man of science, some acknowledgment of the fact seems to be due. Such an instance there was in Mr. Henry Bradshaw, Senior Fellow of King's College, and Librarian of the University, whose sudden removal Cambridge is now mourning. Of his literary ability, his bibliographical accuracy, his mastery of one important period of English poetry, and his knowledge of early printed books, this is not the place to speak. Justice to those qualities doubtless is being, or will in due time be, rendered by other writers, better fitted to pronounce an opinion upon them. But here may be appropriately recorded the enthusiasm—for no other word will suit—with which he at all times entered into and aided inquiries, investigations, and researches that most men in his position would have considered to lie entirely outside of their own, and as such to be without any dereliction of duty disregarded. His time, his energy, and his varied attainments were always at the disposal of any member of the University, whose servant, in the highest sense of the word, he rejoiced to be. But there was no need for any one to be a member of the University to obtain his help. Accessible at all times to all who sought him, the asking of a simple question was a sufficient introduction, and whether that introduction was only the prelude to an acquaintanceship which might speedily ripen into a friendship depended far more on the person who asked it than on himself. By the younger members of the University to whom he was known, and the number of them was vast, he was regarded with feelings of affection, that it would seem almost exaggeration to describe, and his influence over them, always tending towards the highest ends, was proportionately great. But here it is more fitting to dwell upon the active sympathy he showed with students of biology. His great intimacy with the late Mr. G. R. Crotch had led him to take an extreme interest in the literature of systematic zoology, and particularly in the precision which is required of those who pursue the branch of it relating to the Coleoptera, not that Mr. Bradshaw must be supposed to have had any knowledge of the subject. It was simply the method of accurate work which excited his admiration, and that method, he has more than once told the present writer, had largely influenced his own bibliographical investigations, the high value set upon which must be told by those whom they concern. Never taking offence, wholly free from pride, always ready to put the best construction on every man's conduct, catholic in all his feelings, Mr. Bradshaw passed away in his College rooms, apparently without any suffering, on the night of the 10th or morning of the 11th of this month—an end to be envied by most men. A. N.

THE COAL-DUST QUESTION

IN the last paragraph of my letter to NATURE (Dec. 31, p. 197), I stated that those who, having investigated the question of the influence of coal-dust in colliery explosions, had come to the conclusion that coal-dust is not, as a rule, the principal agent in an explosion occurring in a dry and dusty mine, appear to have omitted to take one important element of the case into consideration; and in saying so I implied that, if they had not made this omission, their conclusions in this respect would probably have been more in accordance with my own.

All the important experiments with coal-dust on a large scale have been made in wooden boxes or galleries of greater or less length, open at one end and closed at the other. The ignition or explosion has usually been begun at or near the closed end, and been propagated towards the open end, driving part of the contents of the gallery out into the air in front of it.

Certain conclusions in regard to colliery explosions have been drawn from the results obtained on this small scale which appear to ignore the fact that the conditions here prevailing are far less favourable to the propagation of the coal-dust flame than those which obtain in a mine at the instant an explosion is sweeping through it. For, it is obvious that in the former case the air is practically at *constant pressure* while the explosion lasts, whereas in the latter case it is practically at *constant volume* during the same period. But as the amount of heat required to raise the mixture of air and coal-dust to the temperature of ignition in the first case is greater than that required to effect the same result in the second case in the ratio of 1·41 to 1, it follows that an explosion having been once begun in either case will be propagated much more rapidly and surely in the mine than in the apparatus. Thus it is that a kind of coal-dust which produces comparatively feeble results in the apparatus may give rise to very disastrous consequences in the mine.

An illustration of this difference of behaviour under the two sets of conditions has been furnished by the dust of Camphausen Colliery in Germany. When subjected to the experimental test in the large apparatus at Neunkirchen, already described in these pages, it was found to be far down the list in point of relative danger, and was pronounced to be, like most of the other dusts in the same list above and below it, of a comparatively harmless

nature. But when an explosion subsequently occurred in the mine, and traversed the whole length and breadth of the workings, which were known to be practically free from fire-damp at the time, producing the most disastrous effects, the fallacy of the conclusions drawn from the experimental results was rendered abundantly evident.

In the whole of my papers on this subject, and most pointedly in my last article on coal-dust explosions published in *Iron*, in the year 1878, I have carefully indicated that a difference was to be expected in the behaviour of dust ignited under the two conditions named. It has therefore been with feelings of considerable surprise that I have observed members of the French, English, and German Mining Commissions, and others who have investigated this subject since the publication of my first paper, one after the other pronounce some very decided opinions as to the relatively subordinate part which coal-dust plays in a colliery explosion, while at the same time they were neglecting to take into account this very simple and yet all-important element. W. GALLOWAY

VESUVIAN ERUPTION OF FEBRUARY 4, 1886

THE rent that was formed on May 2, 1885, in the upper part of the great cone (NATURE, vol. xxxii. p. 55) gave issue to lava until December 25. A small quantity again issued between January 2 and January 5, 1886, after which no more made its appearance till this new outburst. In consequence of the rise of level of the magma in the chimney, the cone of eruption has grown very much during the last month.

On February 4, at about 8 p.m., lava broke forth at the foot of the old crater ring of 1881-2 at a point bearing from the main vent about 10° W. of N., traversed the crater plain, which is here very narrow, in a somewhat oblique direction, and ran down the slope of the cone between north and north-north-east. The lava soon reached the foot of the cone, but even up till midday to-day, when I left the mountain, it had not yet commenced to cross the Atrio del Cavallo. The eruption took place from probably the same dyke that gave rise to that of January 9, 1884.

To-day, February 6, the lava bubbles up like a spring at the foot of a hill, and flows for some distance in a kind of trough which it has raised on each side of itself above the level of the crater plains. After a short distance it enters one of its own tunnels to reappear again at some distance. It was very interesting to watch its welling, and from time to time the bursting of a steam bubble as big as a bucket, which would throw up splashes against the imperfect arch at the immediate exit. These splashes partly adhered to the roof and partly fell, drawing out the suspended portion into irregular strings, illustrating the formation of the stalactitic lava that is so common in lava fumaroles.

The chloride crusts in the neighbourhood were uncommonly rich in copper, so that my boot-nails were thickly plated with that metal.

The lava makes its appearance at about 100 yards from its entrance in the tunnel near the main spring, although it is now divided into two streams. The eastern, which is the largest, is 1 metre broad; I plunged a stick in to the depth of 1 metre, but the shortness of the stick and the great heat prevented me from touching the bottom. The current ran at the rate of 1 metre per 6 seconds, which, making allowance for viscous drag at the edges and bottom, will give an output of at least 360 cubic metres per hour, or at least 17,280 cubic metres during the 48 hours up to 8 o'clock this evening. The more western stream was 50 centimetres broad, over 1·20 metres deep (as far as I could reach with my stick), and flowed at the rate of 1 metre in 8 seconds. Giving a loss of 2 seconds of speed from drag at sides and bottom, we have an output, for 48 hours, of 10,368 cubic metres. The two streams together would, therefore, have afforded, since the commencement of the eruption, 27,648 cubic metres.

As the altitude of the lateral outlet is much more than that of May 2, both on the night of the eruption and the following one, the volcano showed the *first stage of activity* as judged by the appearance of the main vent.

This winter the mountain has been covered by snow several times, and to-day it extends down nearly to the level of the Observatory. During our ascent we had to walk through a stratum of about 8 inches, though much thicker in the drifts. Two-thirds of the crater and part of the cone of eruption were also covered.

I should have sent news yesterday, but, on attempting an ascent, I was driven back by wind, rain, and mist.

Naples, February 6 H. J. JOHNSTON-LAVIS

TIDAL FRICTION AND THE EVOLUTION OF A SATELLITE

A PAPER by Mr. James Nolan has recently appeared which is devoted to an adverse criticism of my views concerning the effects of tidal friction as a factor in the evolution of the moon and earth.

The title of the pamphlet, "Darwin's Theory of the Genesis of the Moon,"[1] shows, I think, that the author has misconceived the scope of my work. It was not supposed that the investigation threw light on the actual mode of genesis of the moon, but was rather applicable to the subsequent history of the moon and earth. Mr. Nolan attributes to me views as to the condition of the moon immediately after her birth which do not appear a just interpretation of my writings, and although it might have been well to use more guarded expressions in some passages, the justice of his condemnation of the whole theory cannot be admitted. He sums up his case by the three following propositions:—

"(1) That the moon could not have existed bodily so near the earth as the greatest initial distance fixed.

"(2) That in any form possible there she could not have receded by the agency assigned—tidal friction.

"(3) That, if a modification be made by allowing her to have separated at a greater radius than that corresponding to a period between 2 and 4 hours, the moon would be no longer traceable to the earth's *present* surface on which condition the theory has been founded."

The first of these propositions is interesting, and I have to thank him for drawing my attention to it.

When a small satellite revolves about a planet with a certain proximity, the sum of the centrifugal and tidal forces may be such as to overbalance the gravitation towards the centre of the satellite. When this is the case, the satellite cannot exist as a single mass. The complete solution of the problem, concerning which Mr. Nolan adduces certain elementary considerations, is of extreme difficulty. At present I do not wish to go into this question, but shall consider the point on another occasion. It may, however, be admitted that the moon could not subsist as a single continuous body with its surface in contact with the earth.

On p. 4 he quotes a passage from the abstract of one of the papers (*Proc. R.S.*, No. 200, 1879), which must be surrendered; it is as follows:—

"The coincidence is noted in the paper that the shortest period of revolution of a fluid mass of the same mean density as the earth, which is consistent with an ellipsoidal form of equilibrium is 2 hours and 24 minutes; and if the moon were to revolve about the earth with this periodic time, the surfaces of the two bodies would be almost in contact with one another."

Now, since 1879 it has been shown by Sir William Thomson that the ellipsoidal form referred to could not

[1] Geo. Robertson and Co., Melbourne, Sydney, Adelaide, and Brisbane, 1885. Pp. 16.

subsist, because it is dynamically unstable. It does not, then, seem worth while to consider the remarks made on that passage.

With regard to the first proposition that, if the moon separated from the earth near the present earth's surface, it can only have subsisted as a flock of meteorites, my own words may be quoted as follows:—

"The planet then separates into two masses, the larger being the earth and the smaller the moon. I do not attempt to define the mode of separation, or to say whether the moon was initially more or less annular. At any rate it must be assumed that the smaller mass became more or less conglomerated, and finally fused into a spheroid, perhaps in consequence of impacts between its constituent meteorites, which were once parts of the primæval planet. Up to this point the history is largely speculative, for, although the limiting ellipticity of form of a rotating mass of fluid is known, yet the conditions of its stability, and *a fortiori* of its rupture, have not as yet been investigated. . . . At some early stage in the history of the system the moon has conglomerated into a spheroidal form."[1]

When, however, Mr. Nolan goes on to his second proposition, and states that this amounts to saying that the moon must have been a ring of fragments revolving in the plane of the equator, and that such a ring must be uniformly distributed and therefore incompetent to raise frictional tides, it is not easy to follow him. Is there any objection to the existence of a flock of meteorites? And would not such a flock raise tides in the planet which, if subject to friction, would introduce forces tending to make the meteorites recede? It seems that there is no such objection, and that the flock of meteorites would follow the same fate as the satellite when conglomerated in a single mass.

The difficulties which are raised by the author in the conception of the conglomeration are such as meet us in all evolutionary theories, and whether or not it is possible as yet to see our way mentally through the changes which may have taken place, yet it is generally admitted that conglomeration took place in some way.

He then points out that no other satellite is traceable up to the surface of its planet, and concludes that it is a coincidence that the masses and periods of the moon and earth are apparently such as fit into the theory. No one has pointed out the non-existence of such a satellite more clearly than I,[2] but the absence of reference to my work seems to show that Mr. Nolan has not looked at it. It is not then surprising to read: "Is it not very illogical to suppose that the moon originated in a way which cannot have been the way of origin for other planets and satellites?" And the reader of this sentence would hardly think that my position is that there is a probability that a cause which was subordinate in the history of the other planets was predominant in the case of the moon and earth, and that it is proved numerically that in the terrestrial sub-system the actual distribution of masses and momenta (the factors governing tidal friction) differs at least as much from the corresponding factors in the other planetary sub-systems as the supposed modes of evolution.

On p. 13 we read:—

"There is a law, according to which two heavenly bodies cannot revolve about their centre of gravity with their surfaces nearly in contact, unless one be smaller than the other by a certain amount, and, further, that the small one be denser than its companion by a certain value."

I do not know where to find the proof of such a law, and at the present moment am disposed to doubt its correctness.

[1] *Phil. Trans.*, part 2, 1880, pp. 880-81.

[2] "On the Tidal Friction of a Planet attended by several Satellites" *Phil. Trans.*, part 2, 1881).

Next, on p. 14, we find:—

"Rapid rotation would never cause a quantity of the matter of a body to become piled up at one particular place, and form into a separate single body there of any appreciable size."

Now very recently M. Poincaré has rigorously proved in a very remarkable paper[1] the possibility and even the dynamical stability of such a "piling up," and has given a sketch of the mode of separation of a portion of the mass of rotating fluid. In a paper of my own, now nearly finished, the same problem is treated, but from a different point of view.

It will be perceived from the quotations that the pamphlet is true to its title, and refers almost entirely to the genesis of the moon. This affords some proof that my speculative remarks hazarded as to the mode of origin of the moon, were not so guarded as was intended. The justice of the third of Mr. Nolan's propositions may, however, be denied, and certainly the theory cannot be held to depend on the genesis of the moon at the *present* surface of the earth.

The present opportunity will be convenient for a short reiteration of my point of view with regard to the whole subject.

In tidal friction we have a *vera causa* of modifications in the configuration of the earth and moon. If we adopt provisionally the hypothesis of an adequate lapse of time, we can trace the changes, and find that the obliquity of the ecliptic, the eccentricity of the lunar orbit, and its inclination to the ecliptic (all unmentioned by Mr. Nolan), the lunar periodic time, and that of the earth's rotation, are co-ordinated together by supposing that the moon first had a separate existence at no great distance from the present surface of the earth, and with small differential motion with respect thereto. Then it is maintained that this co-ordination is so remarkable as to give good reason for accepting the hypothesis as in accordance with truth. Concerning the earlier stage in which the moon may be supposed to have separated from the earth, nothing more than conjecture is possible, but undoubtedly the condition adduced by Mr. Nolan escaped my notice.

In examining the rest of the solar system, it is found that, amongst other things, the Martian satellites afford a striking confirmation of the influence of tidal friction, and that the system of the moon and earth presents features so distinct from those of the other planets, as to justify the belief that tidal friction, subordinate in its influence on the other systems, may have been predominant in our own. The theory is also found to throw light on the distribution of satellites in the solar system.

It is as yet too soon to say how far these views embody the truth, but even should they be found untenable, yet certainly the determination of the effects of tidal friction on a system of planets and satellites is a problem of physical astronomy which was well worthy of attack.

G. H. DARWIN

ON THE SOUND-PRODUCING APPARATUS OF THE CICADAS

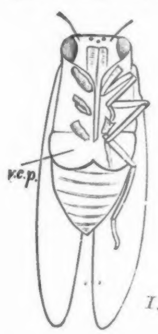
HAPPENING to refer to Prof. Jeffrey Bell's "Comparative Anatomy and Physiology" on the question of the sounds produced by insects, I read, with reference to the Cicadas:—"The sound seems to be produced by the vibration of membranes, placed on either side of the stigmata of the metathorax, and set in motion by the respiratory air" (p. 389).

As this wind-instrument theory of Landois seems to be supplanting, in our text-books and popular natural histories (*e.g.* Cassell's), the drum theory advocated by Réaumur and the earlier writers, I think it permissible to draw attention to certain observations I made on this

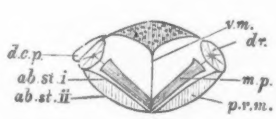
[1] *Acta Mathematica* (1885), 7, 3, 4, "Sur l'équilibre d'une masse fluide animée d'un mouvement de rotation."

subject some six years ago. They were published in the not readily accessible *Proceedings* of the South African Philosophical Society (1879-80, part iii. p. 161), and were not illustrated by any figure.

The Singerjie (*Platypleura capensis*) is a well-known and tolerably abundant insect at the Cape; and few visitors to the shores of Table Bay can have failed to notice, in the hotter months of the year, the sharp shrill metallic sound produced by the "little singer." It is soon found that the male Cicada alone possesses the power of singing, the female—recognised at once by the long ovipositor folded beneath the abdominal somites—being dumb. If the ventral surface of a male singerjie be examined (Fig. I.) two large ventral cover plates (*v.c.p.*) are seen, one on either side, meeting in the central line and extending backwards from the metathorax over the anterior abdominal somite. On turning the insect over and looking at the dorsal surface, two very much smaller dorsal cover plates are seen extending forward from either side of the first abdominal somite. If one of these plates be removed with fine pointed scissors, there is seen the wrinkled surface of a thickish chitinous membrane, the drum. Turning the insect over again, so as to examine more carefully the ventral aspect, and removing one of the ventral cover plates, two membranes are disclosed, separated by a transverse chitinous support. Of these the anterior is white, narrow, and opaque, the posterior (*p.r.m.*, Fig. II.) translucent, oval, and tightly stretched.



I.



II.

The transverse chitinous support (*ab.st.*i) is the sternum of the first abdominal somite; the membranes are intersternal membranes which would seem to be specially modified to act as resonators. The second ventral cover plate may now be removed, disclosing the anterior and posterior resonator membranes of that side; the anterior resonator membrane of each side may be cut through; and the abdominal portion of the insect may be separated from the thorax. When this is done there are seen, taking their origin from the mid-line of the first abdominal sternum (Fig. II., *ab.st.*i), two muscular pillars (*m.p.*), each of which, proceeding upwards and outwards, terminates in a chitinous plate, the upper surface of which is, in turn, connected by a fine ligament with the drum (*dr.*). Under a low magnifying power this drum is seen to be strengthened with brownish ribs, which, together with its general elasticity, cause it to spring back after it has been drawn forward by the action of the muscular pillars, the fibres of which are beautifully striated. Each time the drum is drawn forward and springs back, by the alternate contraction and relaxation of the muscular pillars, a sharp click is heard, as may readily be proved experimentally on the dead insect. That the well-known metallic sound is produced by a rapid succession of such clicks is put beyond question by the fact that, by irritating the muscular pillars in a freshly killed insect, the singing noise may be set agoing, and will then continue for several seconds or even minutes. This I had the pleasure of demonstrating to Mr. Roland Trimen, F.R.S., curator of the Cape Town Museum, the abdomen singing merrily when the head and thorax had been pitched out of window or destroyed. A weak current of electricity would also cause the singing to commence. The sound generally ceased after a while in a few isolated clicks, and at that time the waves of contraction in the muscular pillars were plainly visible. The singing noise was less sharp and clear than in the living insect, owing probably to the disruption of some of the resonator membranes; and I have noticed that rhythmical motions of the abdomen in the live insect produce rhythmical alterations in the intensity of the sound. The cover plates are doubtless mainly for protection; but the fact that on their removal the sound is less full and intense shows that they also may play the part of sounding-boards.

Fig. II. is a slightly diagrammatic view of the severed abdomen as seen from the anterior end. *ab.st.*i and ii are the sterna of the first and second abdominal somites: *p.r.m.* the posterior resonator membrane stretched between them; *v.m.* a vertical membrane; *m.p.* the muscular pillars; *dr.* the drum; and *d.c.p.* the dorsal cover plate of the right side, that of the left side being removed.

I may mention, by way of appendix, that in this species the rostrum contains only three stylets: two lateral, toothed on their external edges; one central and smooth. Although this central style shows, in some cases, indications of its having arisen by coalescence of two lateral styles, it is distinctly one and indivisible.

C. LLOYD MORGAN

University College, Bristol

RADIANT LIGHT AND HEAT[1]

V.

Evidence afforded by the Spectroscope as to the Nature of the Elements

THE point of greatest speculative interest connected with our subject is perhaps that regarding the constitution of the so-called elements.

What light, it may be asked, does spectrum analysis throw on this vexed question? Does it lead us to imagine that these bodies are truly elementary? Or to believe that they are in reality compounds which might be broken up if we had sufficiently powerful instruments for this purpose at our disposal?

I shall begin my remarks on this subject by taking it for granted that the constitution of matter is atomic and molecular.

When, therefore, two chemically different substances combine together we have the union of two heterogeneous atoms, forming a molecule of the compound substance. Thus, when an atom of chlorine and one of sodium combine together we have, as a result of the combination, chloride of sodium or common salt, and an ultimate molecule or compound atom of chloride of sodium may be described as the smallest portion of that substance which possesses all the properties of common salt, and which, if divided further, would be split up into one atom of sodium and one of chlorine.

The molecules of bodies are very frequently so placed as to have an attraction for each other, under the influence of which the body assumes a solid, or, it may be, a liquid state.

Sometimes, however, we have the body in the state of gas, in which the various molecules are so far apart as to have no perceptible attraction for each other. It is by means of such a gas that we can best study the properties of molecules as far as radiant light and heat are concerned. Now, spectrum analysis unquestionably tells us that at comparatively low temperatures and great nearness of particles we have a comparatively complicated

[1] Continued from p. 254.

molecular structure. When, however, the temperature is high and the particles far apart, this structure, as revealed by its spectrum, is much simpler. A process of splitting up has taken place in the interval.

While, however, this is universally allowed, there is a difference of opinion as to the nature of this simplification, which, we are assured by the spectroscope, has taken place. Thus we have already seen that in gaseous water or steam we may have, at a somewhat high temperature, a considerable variety of structures and a partial dissociation of the various compound molecules. In such a case we have at the same time portions of the compound and portions of the components, thus exhibiting a more or less complicated structure of the gas. When, however, the temperature gets very high, the dissociation is practically complete, and the compound structures disappear, leaving us with molecules of oxygen and hydrogen. But what will happen if we treat the vapour of iodine in a similar manner? It will be allowed that as the temperature gets higher we shall have a simplification of molecular structure accompanied and exhibited by a great change of spectrum, but will the iodine ever split up into components which bear to iodine a relation similar to that which oxygen and hydrogen bear to water?

In fine, we call iodine a simple body because in the conditions in which we are placed in our laboratories we cannot decompose it; but what is it in the vacuum-tube and under the spectroscope? Is it still an element, or does it give any evidence of being a compound?

It is taken for granted that at high temperatures its molecules split up, but do they split up into portions of iodine or into portions of the components of iodine? In discussing this and similar questions we shall begin by acknowledging that the strongest and best proof of the compound nature of any element is the exhibition of its components in a separate state, while at the same time we must confess that we are at present unable to do this for the so-called elements. Nevertheless this inability forms no ground for the assertion that the elements are simple bodies, inasmuch as certain substances which we know to be compound reveal their components momentarily in the spectral flame. There is a momentary dissociation at a high temperature followed by a reconstruction at a low.

A good instance of this is the yellow flame produced by introducing chloride of sodium into a Bunsen's burner. This yellow flame attests the existence of sodium in the free state, but this existence is merely temporary, and at the end of the process there is no perceptible trace of the presence of this metal. Thus the only difference between the experiment in which the presence of sodium is temporarily revealed and that in which splitting up takes place when the various elementary gases are brought to a high temperature *may be* that in the former instance we can obtain the sodium by another means, whereas in the latter experiments we cannot obtain these constituents by any other means. We say *may be* because we know that our powers are limited and can very well conceive their extension in the future as we know they have extended in the past. We think it, therefore, unphilosophical to assume that there is any real difference between those bodies which we cannot decompose and those bodies which we can, unless there is some good reason for this distinction apart from our inability to decompose the former. Let us now, therefore, inquire whether any such grounds exist.

Our first remark is that in certain respects the elements, with one or two exceptions, may be looked upon as belonging to a distinct family each member of which possesses the same or nearly the same *atomic heat*. This means that the amount of heat necessary to raise through a given temperature range an atom of any one element is equal to that necessary to raise through the same range an atom of any other element.

This fact was first discovered by Dulong and Petit, and is expressed by saying that the product of the specific heat into the atomic weight, or the atomic heat, as this is called, is nearly the same for all the elements.

This peculiar law is not confined to the elements, for it has been found that in all compound bodies of similar atomic composition the product of the specific heat into the atomic weight is likewise constant. This product is, however, greater in the class of compound bodies than it is for the so-called elements. For the latter the product is about 6, while for the chlorides of barium, strontium, calcium, &c., it is over 18, and for the carbonates of lime, barytes, &c., it is nearly 22.

Thus the distinction which the elements enjoy as a family consists in the fact that their atomic heat is less than that of families of compound substances. In order to perceive the physical meaning of this peculiarity let us imagine that we make a mixture of two substances, A and B, which have no sort of chemical attraction for each other. Now in order to heat this mixture through a certain temperature range, the heat required will be the sum of the heats required for the two components, and neither more nor less, the one being in this respect absolutely independent of the other.

Next let us suppose that A and B are both chemical compounds, but that the atomic constituents of a compound atom of A exercise on each other (in order to form the compound atom) attractions vastly greater than those which the compound atoms of A so formed exercise upon each other.

Let us also imagine that a similar law holds for B, so that in fine we have to deal with the following forces, some of which are strong and others weak. Thus we have:—

(α) The strong forces exercised by the various chemical constituents of a compound atom of A on each other.

(β) The strong forces exercised by the various chemical constituents of a compound atom of B on each other.

(γ) The relatively feeble forces exercised by the various compound atoms of A upon each other.

(δ) The relatively feeble forces exercised by the various compound atoms of B upon each other.

(ϵ) The relatively feeble forces exercised by the compound atoms of A upon the compound atoms of B.

Under these circumstances there are perhaps theoretical grounds for imagining that when we mix A and B together not only shall we have, as above-mentioned, an independence between the specific heats of A and B, but in addition the specific heat of a compound atom of A will be found to be equal, or nearly so, to that of a compound atom of B.

If we now apply these principles to the so-called elementary bodies, we shall, I presume, be all willing to own in the first place, that (assuming for the sake of argument that they are in reality compounds) the force which binds their various constituents together must at any rate be vastly greater than that which represents the attraction of one so-called element for another. Imagine, now, one atom of barium and two of chlorine to combine together to form one compound atom of chloride of barium, we may safely assert that the strength of the chemical ties which bind together the various constituents of this compound atom must be vastly weaker than those which bind together the assumed constituents of the element chlorine or of the element barium. In conformity therefore with the suggestions we have ventured to make we might expect two things to happen:

First, the heat necessary to heat through a given temperature range a compound atom of chloride of barium ought to be nearly equal to the sum of the heats necessary to heat through the same range an atom of barium and two atoms of chlorine.

Next the heat necessary to heat through this range an atom of chlorine ought to be nearly the same as that

necessary to heat through the same range an atom of barium, provided both substances are taken in the same state—both solids for instance.

If then the specific heat of an elementary atom is represented by 6, that of a compound atom of chloride of barium will be represented by 18. This is in truth the law which Kopp has found to hold with respect to the atomic heat of compound bodies, and the theoretical conclusion to be derived from it, and that of Dulong and Petit, is, not that the elements are essentially different from the compound bodies, but that, if compound, the forces which bind together their constituents are vastly more powerful than those which bind together the so-called constituents of bodies known to be compound.

Again, if we compare together the atomic weights of the so-called elements with those of compound bodies, we shall find that as a whole the former are smaller than the latter—that is to say, the family of elements have on the whole smaller atoms as well as smaller atomic heats than the families of compounds. Now, if the elements are in reality compounds we might expect in like manner that those which have the smallest atoms should have the smallest atomic heats.

We have great reason for supposing that this is the case, for, although we have not obtained the specific heat of either oxygen or hydrogen in the solid state, Kopp has found that his law with regard to compounds will only hold good under the hypothesis that the atomic heats of hydrogen and oxygen are decidedly less than those of the great bulk of the elementary bodies, that of hydrogen being likewise smaller than that of oxygen. Furthermore carbon and boron are two elements which have small atoms. Now if we make the observation at ordinary temperatures it will be found that the atomic heats of these two elements are decidedly less than those of the great bulk of the elements. In fine, elements of small atomic weight and presumed simplicity of structure appear to bear to those of great atomic weight a relation similar to that which the elements as a class bear to the compounds as a class, as far as atomic heat is concerned.

On the whole the result of this discussion appears to be in favour of the so-called elements being in reality compound structures the components of which possess attractions for each other vastly greater than those exhibited in ordinary chemical combinations.

In connexion with this branch of my subject I may allude to the peculiar family relation between certain elements which all chemists are now agreed in recognising.

This means that the various members of a group of the elements consisting, let us say, of A, B, C, and D, bear to one another some peculiar relation different from that which they bear to the other elements. Now this is precisely what happens in the case of groups of substances which we know to be compound, and the impression is thus conveyed that the elements themselves consist of varied groupings of some still simpler substance. Indeed it seems quite possible that there may be only one kind of primordial atom, and the fact that the force of gravitation bears a constant relation to mass quite independently of chemical constitution seems to speak strongly in favour of some such hypothesis.

Let us now try to picture to ourselves what would have happened had spectrum analysis been known as an instrument of research at the time when we were yet unable to isolate the metal sodium. Under such circumstances chloride of sodium and caustic soda would both be considered as separate elements and the spectra of both these bodies exhibiting the same yellow line would lead to the conclusion that these substances contained some common principle which was momentarily dissociated from its surroundings in the spectral flame. This leads us to ask whether there are any such coincident lines in the spectra of the various so-called elements besides those which may be caused by common impurities. Lockyer, who has greatly studied this subject, tells us that short-line coincidences exist between many metals, the impurities of which have been eliminated, or in which the freedom from mutual impurities has been demonstrated by the absence of the longest lines. Some of his results are exhibited in Fig. 25, in which the lines marked – are due to impurities, while those marked + are common or basic lines. It would thus seem that these short-line coincidences cannot be due to impurities, and the question at once arises whether they do not indicate the presence of some common principle in the spectra before us momentarily dissociated from its surroundings by the high temperature.

It is important here to explain what we really mean when we speak of a coincidence between two spectral lines. We mean simply that there is no perceptible difference in their position when examined with an instrument of a certain power. Mr. Lockyer therefore did not with his instrument perceive any such difference in the spectral position of certain short lines given by various elements. Messrs. Liveing and Dewar, however, applied to some of these lines an instrument of greater power, and succeeded in showing that in many cases there was a slight difference between their spectral positions.

This result raises a new question. We have now to ask ourselves what, under these circumstances, is the value that we can attach to this very near but not quite absolute coincidence between certain short lines of various elements?

Now, in comparing together certain absorptive spectra of compound bodies which have some principle in common, we learn from the researches of Russell and others that we can sometimes trace a band presumably due to the common principle, the spectral position of which is, however, slightly different in the various compounds. The want of perfect freedom may, it is imagined, alter slightly the time of vibration of the molecular groupings, and thus displace the spectral position of the absorption bands. I think we are justified in imagining that something of this kind may take place in the elements, in which, the forces being so intense, our highest attainable temperature may be insufficient to produce complete dissociation. In this case the want of complete concordance in the short lines common to various elements, or *basic lines*, as these have been named by Lockyer, may denote nothing else than this absence of power.

It is imagined that these approximate coincidences are too frequent and too near to be due to chance, but this is a subject that will ultimately require mathematical investigation. In fine, we may conclude this short account of the terrestrial evidence regarding the nature of the elements by saying that—(1) there is no proof that they form a class essentially different from compound bodies, but much to the contrary; and (2) that, if compound, the forces which bind their constituents to one another must be very great.

Before discussing the spectra of the sun and stars it may be well to pause for a moment and ascertain what we mean when we say that sulphur, for instance, is an element. It is quite clear that solid sulphur, liquid sulphur, and gaseous sulphur are different things; also, we may have two kinds of solid sulphur, while if we take the spectrum of gaseous sulphur there is little doubt that the molecular groupings suffer vast changes as the temperature rises.

Now, in all its various states we still call the substance sulphur, because if we bring it down to the temperature of our laboratories it will combine with other bodies as sulphur and as nothing else. Thus the word *sulphur* does not in reality mean a definite arrangement of matter. Similar remarks apply to other elements, several of which are in the form of gas and give us their spectra in

vacuum-tubes. Now it is quite possible that in one of these vacuum tubes as we pass the spark through it, we may have various atomic structures, some of which if we could carry them away to a separate place might on cooling present us with something we had never seen before. But this is precisely what we cannot do in the conditions under which we are placed, nevertheless it can be done in the atmospheres of the sun and stars. Prof. Pierce has shown that in such atmospheres where gravity is very powerful, the heavier molecular structures will

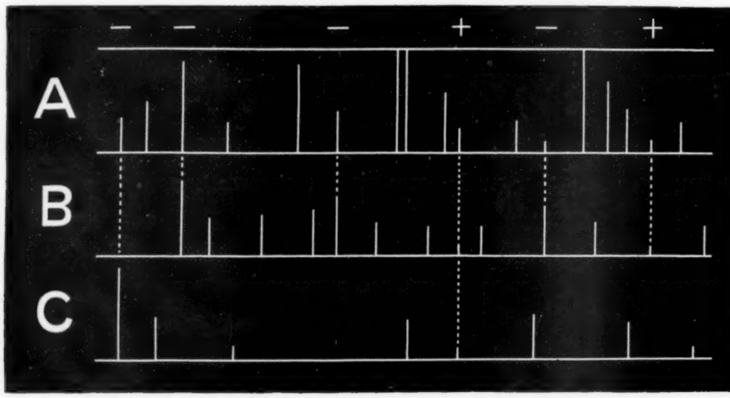


Fig. 25.

naturally separate themselves from the lighter, and seek a lower level. Lockyer therefore imagines that in such atmospheres there is the separation of molecular structures always going on, the heavier falling downwards until they reach a region of higher temperature where they become dissociated or broken up, and the lighter mounting upwards until they reach a region of lower temperature, where they combine together, and hence become

Fig. 26.

heavier. This kind of sifting process must not be confounded with the rapid motions of ascent and descent of the various solar currents, sometimes carrying a body of particles downwards, and thus heating it in the process and sometimes carrying it upwards and cooling it in the process. Both of these causes must be regarded as at work together in the solar atmosphere, and they give us no doubt the best explanation of a very peculiar circumstance

which Lockyer was the first to observe. It appears that lines which, judging from terrestrial experiments, belong to one element, sometimes appear in the solar spectrum as distorted or displaced in different directions, indicating perhaps that the substance producing the one line is moving towards the eye with great velocity, while that producing the other is moving in a contrary direction. It is thus certain that the substances producing the two lines must be in different places, and under these circumstances we can hardly come to any other conclusion than that these lines are given out by different molecular groupings which have become separated from each other by the sifting process already mentioned.

From Fig. 26 it will be seen that different rates of solar motion are exhibited by different iron lines.

It would thus appear that a study of the solar spectrum is likely to furnish us with much information regarding the modes of vibration of molecular structures. It would also seem that in view of these facts we should revise our nomenclature. What, for instance, do we mean when we say that iron occurs in the sun? Clearly nothing more than that certain molecular structures in the sun's atmosphere are the same as certain terrestrial molecular structures momentarily formed when we obtain the spectrum of iron. But if we could seize upon the various particles that unite in giving out some one iron line, and put them into a bottle, we might perhaps find that they were not iron, and they might even be different from the thing obtained by treating some other iron line in the same way.

The following statement of Mr. Lockyer's views is taken from the Report of the Solar Physics Committee:—

"The view of the construction of the solar atmosphere to which Mr. Lockyer has been led, may be stated as follows:—If the atmosphere of the sun were quite tranquil, and if we could see the spectrum of a section of it, we should see it divided into an almost innumerable number of layers, each with its appropriate spectrum. So far from each substance (with some notable exceptions), *as determined by a spectral line*, extending very far above or below its normal position, it would be confined to one heat-level, and the spectrum, taken as a whole, would get simpler as we approach the photosphere from without. The metallic elements, instead of existing as such in a so-called 'reversing-layer,' resting on the photosphere, are entirely broken up there, and their germs are distributed throughout the atmosphere, the molecular groupings getting more complex as the distance from the region of greatest heat increases. The Fraunhofer spectrum, as regards any one element, does not result from the vibration of the molecules of that element existing as such at any given height in the sun's atmosphere, but results

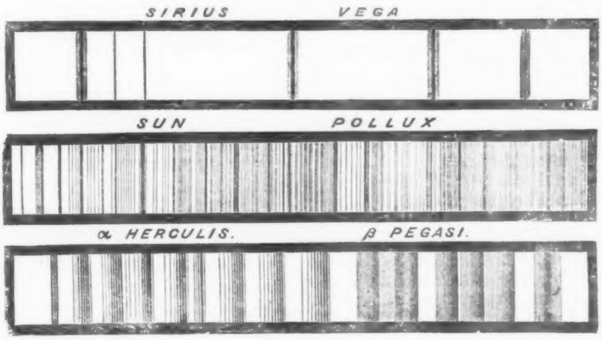


FIG. 27.

from an integration of the vibrations of the germs of that element existing, perhaps distributed, from the top of the atmosphere to the bottom."

It may be said, however, that, while we have strong evidence of a splitting up and also of a sorting or sifting process of the various molecular structures going on in the sun, we are yet without evidence that the molecular structures of two different elements can be split up into the same component. The reply to this will be found in a statement made by Mr. Lockyer (*Proc. R.S.*, December 15, 1881) that the greater part of the lines seen at the bottom of solar spots and in solar flames are lines apparently common to two or more terrestrial substances with the dispersion employed—in other words, basic lines, as these have been termed. He has exhibited some of these results in a diagram which will be found in NATURE, vol. xxiv. p. 323. Now, even if we imagine that the coincidence in position of these lines, as derived from two or more substances, is not absolute, yet the fact that such lines form the greater portion of the spectra belonging to the hotter regions of the sun is a very significant one, and surely implies something more than a mere chance correspondence.

Rutherfurd and Padre Secchi were the first to attempt a preliminary classification of the stars into groups, but for a spectroscopic analysis of these bodies we are especially indebted to Dr. Huggins. Lockyer thus sums up the information which we have thus obtained (December 12, 1878), the symbols indicating the metallic lines visible in the various spectra:—

Hottest Stars	Lines of	H + Ca + Mg
Sun... ...		H + Ca + Mg + Na + Fe
Coolest Stars		— — Mg + Na + Fe + Bi + Hg.
Coolest ...	Fluted bands of	... ... Metalloids.

I may here remark that the hottest stars in the above table are chosen because of their superior brilliancy, and the cooler stars because of their inferior lustre. We are thus entitled to say that the most brilliant and presumably the hottest stars are those in the spectra of which the prominent black lines are the lines of hydrogen, calcium, and magnesium, while in those stars of which the sun is a type we have in addition lines of sodium and of iron. In the cooler stars hydrogen and calcium have disappeared, and we have lines of magnesium, sodium, iron, bismuth, and mercury, while in the coolest stars of all we have no metallic lines but only fluted bands of metalloids. In these last we may imagine that all the metallic lines have

disappeared through association at the comparatively low temperature of the stars.

Fig. 27 gives us a representation of the three chief types of stellar spectra.

It is thus manifest that in stars where the temperature is very high and the dissociation very great we have fewest lines, or at least fewest lines of that prominence and thickness which entitle us to associate them with substances existing below the surface of the stellar atmosphere. Here let us pause for a moment and reflect what this implies. If each element were in reality a simple body, and if the splitting up which occurs in the spectrum of each were merely molecular and not atomic, the result of a high temperature in a mass of matter containing presumably all the elements would certainly not diminish the number of the spectral lines indefinitely. For, even suppose that it split up all the molecular structures of each element into their simplest forms, yet on the supposition that they are elements, the ultimate molecular structure for one element would be different from that for another, and there would thus be at least as many molecular structures and spectral lines as there are elements. On the other hand, if these substances are not elements, we may imagine them to be split up into a comparatively small number of ultimate structures, and we might even imagine that at an enormously high temperature everything might be reduced to a single structure.

Thus the fact that in the hottest stars we have the fewest atomic structures is in favour of the hypothesis that the elements are not really simple bodies but compounds, it may be, of some primordial atom.

Let us now sum up the evidence derived from terrestrial and celestial sources in favour of this hypothesis.

First. There is experimental evidence of various kinds tending to show that the so-called elements are not essentially different from other bodies.

Secondly. In the terrestrial spectrum of pure metals at a high temperature certain lines are obtained for some one element that are extremely near, if not coincident, in spectral position with those obtained for some other element or elements. These have been called "basic lines."

Thirdly. We know that in the sun's atmosphere there is a process at work tending to separate the various molecular and atomic structures, and we find that the greater number of the lines given out from the sun's hotter regions are basic lines, such as we have above defined.

Fourthly. In the very hottest stars, where the dissociation is greatest, we have only a few prominent lines given out, these being lines belonging to hydrogen, calcium, and magnesium. I think we must conclude that the hypothesis that the elements are in reality compound bodies offers, with our present knowledge, a very good and simple explanation of the results of spectroscopic analysis in the earth, the sun, and the stars.

Now, bearing in mind the extreme usefulness of some such hypothesis to aid us in collecting facts, I do not hesitate to say that this hypothesis can only be legitimately overthrown in one of two ways. We may either, in the first place, obtain some indisputable fact bearing conclusively against the hypothesis that the elements are compounds and in favour of their being essentially simple bodies, and may thus overthrow the above hypothesis in the same way that Fizeau, by his experiment, overthrew the corpuscular theory of light, if, indeed, it had not fallen to pieces before he made the experiment; or, on the other hand, the hypothesis that the elements are essentially simple bodies may be applied by some skilled advocate to our terrestrial and celestial spectroscopic observations and a consistent explanation of these afforded, simpler and better than that given by the above-mentioned hypothesis. But until either of these two things is done we are justified in using the compound nature of the elements as a working hypothesis.

It would, no doubt, be premature to bring it forward at the present moment as an established theory, because an established theory means a working hypothesis which, having overcome the perils of infancy and youth, lives to justify an honourable and useful existence on the principle of the survival of the fittest. BALFOUR STEWART

NOTES

THE Paris Academy of Sciences has suffered another loss in the death of M. Jamin, Perpetual Secretary for the Section of Physical Science, and the immediate successor of M. Dumas. M. Jamin can hardly be said to have filled his office, as he was attacked by disease of the heart very soon after his nomination. He was elected a member of the Academy in 1858 to fill the place vacated by the death of Pouillet. He was a very eloquent teacher and debater, and a frequent contributor to the *Revue des deux Mondes*. His "Cours de Physique à l'École Polytechnique," is a very extensive work. He also published many papers in the *Transactions* of the Academy of Sciences, and patented an electric light. He was born in 1813, and educated at l'École Normale.

THE death of Mr. Edward Thomas, one of the most eminent of English numismatists, took place on the 10th inst. at Kensington, in his seventy-third year. After a distinguished career in the public service in India, he returned home and devoted himself to the study of the antiquities and history of India and Asia generally. He was a Corresponding Member of the French Institute and of the St. Petersburg Academy, as well as a Fellow of the Royal Society. His writings were very numerous, and many of them are still only to be found scattered throughout the journals of different learned Societies, to which he had contributed for upwards of forty years. Amongst his most important works were his edition of Prinsep's "Antiquities," published in 1858; papers on ancient Indian minerals in the *Journal Asiatique;* on early Sassanian inscriptions, seals, and coins; his essay on ancient Indian weights prefixed to the "Numismata Orientalia" is the standard work on the subject. Between 1848 and 1866 he contributed sixteen papers to the *Journal* of the Royal Asiatic Society on Eastern coins. These were subsequently republished under the title of "Tracts on Oriental Literature."

THE death is announced of Dr. Heinrich Fischer, the mineralogist and professor at the Freiburg University, well known through his work on "Jadite and Nephrite."

IN a lively and interesting article in Tuesday's *Times* on the work of the Smithsonian Institution in the field of ethnology it is urged with some force that the British Government is bound to render a similar service to science in the case of the numerous races under our dominion, many of whom are dying out, or changing their old habits and customs. "All the arguments which could be urged for the maintenance of the Smithsonian Bureau of Ethnology apply to the establishment of a similar bureau for the British Empire. In British India the State from time to time undertakes fragments of the task. Elsewhere it is being effected occasionally and piecemeal. The want is of a body which should carry on the enterprise as a whole, and in a manner to borrow light from one quarter to elucidate the rest. Types of tribal, social, and national existence are vanishing on every side. They are changing, or giving place to new. Some had always the germs of incurable decay in them. British civilisation is treading out others. British dominion, whether directly answerable or not for the mortality, is in the position of administrator, and is bound to keep account of the estate of ancient and curious memories. Being where and what it is, it ought to be executing on a scale yet ampler the work the Smithsonian Institution is doing diligently from and at Washington."

This really forms a part of the much wider question of the duty of the State to science; though with our officials spread everywhere over our world-wide possessions, it ought to be an easy matter to collect abundance of data with which the ethnologist could deal.

M. GRANET, the French Minister of Posts and Telegraphs, is connecting telephonically Paris and Brussels. When the connection has been completed he will also connect Lille and Paris.

IT is satisfactory to learn that success has attended the attempts lately made by the eminent Norwegian naturalist, Herr Bock, and his coadjutor, Herr Schwabe-Hanssen, to introduce a new form of industry into their native land, by utilising some of its numerous beautiful native minerals for the fabrication of various objects of art. For this purpose they have made use of the light-green so-called "precious" serpentine, which, although generally scarce, occurs in abundance at Modum, where ophite and magnetite are also found in sufficient quantities to warrant the hope that the supply will repay the necessary cost of raising and working these decorative minerals. Equally valuable for ornamental purposes are the iridescent, or Labrador, feldspar of Fredriksværn, the avanturine of Tvedestrand, and the tulite of Leksvik, near Trondhjem, but hitherto these minerals have not been found in sufficient quantities to admit of including them among the genuine Norwegian materials of decorative industry.

HERR WERENSKJOLD reports in *Naturen* that on January 5, at 5.20 p.m., he noticed a so-called fire-ball, which was observed in the district of Aas to be moving in a south-westerly direction near Orion's Belt, till it disappeared behind a bank of clouds in the neighbourhood of β Ceti. Its motion was undulatory and slow, and in size and brightness it resembled Venus on an ordinarily clear evening, while it was surrounded by a luminous circle, whose diameter seemed to the observer to be about 2 metres. It continued visible for fully 20 seconds.

IN an interesting paper on the Bushmen and their language, by Mr. Bertin, published in the last number (vol. xviii. part 1) of the *Journal* of the Royal Asiatic Society, the writer discusses the ethnological position of this people. He agrees with Dr. Fritsch in thinking that they have none of the characteristics which would warrant either of the suppositions that they are the result of a mixture of all the runaway slaves, or that they are the broken remnants of a degraded and decayed population. They can only be said to have decayed when they have accepted a certain measure of civilisation. The area formerly covered by them was much larger, and extended over regions now exclusively occupied by Hottentots and Bantu; but there is no means of knowing how far they extended into the interior, although there is some reason to suppose that at one time they occupied the central part of the African continent. Anthropologically, the Bushmen, Mr. Bertin states, offer all the characteristics of the Negritos, especially of those of the Andaman Islands. The similarity is not confined to the skull, as noticed by Prof. Flower, but extends to the colour of the skin, formation and tint of the hair, absence of hair on the body, proportion of the limbs, smallness of the extremities, and reduced size of the stature. The central part of Africa is not yet sufficiently known to enable us to say with certainty whether the Bushmen may be connected with any other African population; but there was, the writer says, a race, now nearly extinct or obliterated, which shows many of the same characteristics, namely, the Egyptian race of the first dynasties. He thinks it safe to say that both populations came from the same primitive stock, and have been modified by crossing with other races, and many other causes. This stock was a kind of Negritoid race; the ancestors of the Bushmen were thrown on the Hottentot population, whether or not this was indigenous or extraneous—in their tales the Bushmen always speak of a previous population inhabiting the country—and it is no doubt the inevitable infusion of Hottentot blood which has given them the few characteristics they have in common.

HERR L. RUTENBERG, of Bremen, the father of the well-known traveller recently murdered in Madagascar, has presented the Bremen Natural History Society with the sum of 2500*l.* for a Rutenberg Fund in commemoration of the services his son rendered to science.

TWO moderately violent shocks of earthquake are reported to have occurred in Rockland County, N.Y., on January 16 about midnight. They were noticed in various localities, such as Haverstraw, Rockland Lake, Spring Valley, Piermont, Sparkill, Nyack, and Suffern; no damage was done.

AN East Greenland Exhibition at Copenhagen, consisting principally of ethnographical objects brought home by the Danish East Greenland Expedition under Lieut. Holm, is attracting much attention in the Danish capital.

THE proprietors of the Ostrau Karwin mines in Silesia have offered, through the Minister of Agriculture, a prize of 1000 ducats to any one who shall discover a method for extracting coal from pits without occasioning accidents by explosions of fire-damp or combustion of coal-dust.

THE will of the late Prof. Henri Milne-Edwards, F.R.S., has been proved in England, the personalty in this country being over 8000*l.*

THE temperature of German Alpine lakes has been recently studied by Herr Geistbeck. It is shown, *inter alia*, that some lakes have a much wider annual variation of temperature than others. Small depth and large affluent streams are causes of a higher temperature in summer and a lower in winter. The cooling in autumn, it is noted, goes on much more rapidly than the heating in spring; for in autumn the upper layers of water, getting heavier through cooling, sink and give place to others, causing a strong and continuous vertical circulation till the whole mass reaches the temperature of greatest density; but in spring this circulation fails. Large affluents, too, by promoting mixture, cause rapid heating. Herr Geistbeck distinguishes three or four zones in these lakes in midsummer. Down to about 6 to 8 metres the fall of temperature is very slight, only a few tenths of a degree. Then, to about 18 metres, there is a rapid fall, from about 14°–20° C. to 8°. The fall continues to about 50 metres, but is now very slow ($3\frac{1}{2}$° to 4°). Below 50 metres the temperature is about constant and 4·2°–4·5°. The daily variation disappears within the highest zone.

FROM a simple experiment with a small ballistic pendulum (*Wied. Ann.* 36), Prof. Mach estimates the velocity of the wave of explosion of 0·02 gr. fulminating silver to be about 1750 metres (say 5833 feet) per second, and so, very much greater than that of ordinary projectiles. Thus is readily explained how a little of the substance exploded electrically on a glass or metal plate, or a card, fixed in a free position, makes a hole through it. The resistance of the air would appear to have nothing to do with it, for explosion *in vacuo* penetrated a card quite similarly, though with less noise. The gases of explosion acquire, in an immeasurably short time, and with nearly the same density as the solid body, the whole high velocity imparted by the work of explosion. As this is of the order of projectile-velocities, the plate is shot through, the lower half of the exploding mass acting against the upper, and the two acquiring equal and opposite velocities. With paper or tinfoil on a table, explosion produced (by reaction, no doubt) an upward convexity, sometimes with rupture.

IT is the intention of the authorities at the South Kensington Aquarium to endeavour to introduce herrings into the collection of fish now on view there. The difficulty of naturalising this species to artificial existence is very great, as has been proved by former experiments. At sea-port aquaria, however, where a continuity of salt water may be obtained, this difficulty is obviated to a great extent, but at inland aquaria, where the water is seldom changed, it necessitates extraordinary skill to keep them alive.

AT a meeting of the Council of the National Fish Culture Association, held last week, it was stated that the American Government had forwarded another consignment of Salmonidæ ova since the previous week, and the hatchery was now replete with eggs. It was further stated that the hatchery had been reconstructed and enlarged to meet the strain placed upon its accommodative capacity, so that the Association was in a position to incubate any number of ova.

A LARGE supply of salmon and trout ova has been despatched to New Zealand by Sir Francis Dillon Bell, who is most desirous of stocking the waters of that country with Salmonidæ. The ova were obtained by the Tay District Fishery Board, and deposited in the Howietown establishment until ready for shipment. Much is being done to advance the New Zealand fisheries, and the attempts made in this direction have terminated successfully in nearly every instance.

THE additions to the Zoological Society's Gardens during the past week include a Pennant's Broadtail (*Platycercus pennanti*) from New South Wales, presented by Mr. H. Stacy Marks, R.A., F.Z.S.; five Adorned Ceratophrys (*Ceratophrys ornata*) from Buenos Ayres, presented by Dr. F. C. Strutt; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Charles Kershaw; a Common Gull (*Larus canus*), a Black-headed Gull (*Larus ridibundus*), a Kittawake (*Rissa tridactyla*), British, purchased.

OUR ASTRONOMICAL COLUMN

NAVAL OBSERVATORY, WASHINGTON.—The following novelties occur in the programme of work to be pursued during the year 1886 at the Naval Observatory, Washington, recently published:—

"With the great equatorial it is proposed to make observations of some of the fainter stars in the Pleiades to connect them with the bright ones recently measured with the Yale College heliometer. With the 9·6-inch equatorial observations of variable stars will be commenced. A photometer for this instrument has been ordered from Alvan Clark and Sons; a spectroscope by Hilger is ready for attachment."

THE SECULAR NUTATION OF THE EARTH'S AXIS.—M. Folie, having deduced a periodic formula for the secular variations in obliquity and in longitude, applies the designation secular nutation of the earth's axis to these variations. Defining the *normal* equator as a plane the inclination of which to the ecliptic of a certain epoch is equal to the mean obliquity of that epoch, and the intersection of which with this latter plane passes at each instant through the mean equinox of that instant, he concludes that, in virtue of the secular nutation of the earth's axis, the mean pole describes round the normal pole, considered as fixed, an ellipse the major axis of which, directed towards the pole of the fixed ecliptic (*i.e.* the mean ecliptic of the epoch) is sensibly constant during several centuries. The period of the secular nutation is about 30,000 years, differing little from that of the precession on account of the slow motion of the node of the ecliptic, which is only 8″·7 per annum. Assuming a uniform value of 50″ for the secular diminution of the obliquity, M. Folie compares the results obtained from his formula with ancient observations of the obliquity, and is thus led to announce that the empirical expression $\epsilon_1 = -0''\cdot476 + 0''\cdot000018t$ for the annual diminution (where t is the number of years from 1850) satisfies very closely the observations from − 250 to + 1487. This expression, however, gives a considerably greater variation to the secular diminution of the obliquity than that which results from Leverrier's researches.

ASTROPHYSICAL OBSERVATORY OF POTSDAM.—The first part of the fourth volume of the publications of this Observatory, which was published in the latter part of last year, contains three papers. The first of these is by Prof. Vogel, and contains the observations which he made with the great Vienna refractor in 1883 for the purpose of testing the performance of the great object-glass. Prof. Vogel's final verdict is altogether favourable: "The Vienna objective," he says, "leaves nothing to be desired as regards the precision of the images;" and he speaks of using with advantage a power even of 1500 upon planetary markings, a statement which is illustrated by a sketch of part of Saturn's ring, as seen with that magnifying power. His principal observations were, however, spectroscopic, Prof. Vogel utilising the great light-gathering power of the Vienna equatorial for a detailed examination of the remarkable spectra shown by several faint stars, classified by him under types II.*b* and III.*b*; the former including spectra showing both dark and bright lines, and the latter, spectra crossed by dark bands, for the most part sharp towards the red and shaded towards the violet. The bright lines in the former class, with the exception of the green line of hydrogen, have not been identified with those of any element. The principal bands of the latter class Prof. Vogel refers, as Dr. Dunér does, to the absorption exercised by hydrocarbons in the atmosphere of the star. The paper also contains a number of observations of nebulæ, principally planetary, and is illustrated by four lithographic plates.

The second paper contains meteorological observations made in the years 1881 to 1883, and the third is a very careful investigation by Dr. G. Müller of the influence of temperature on the refraction of light through prisms, of various kinds of glass, of Iceland-spar and rock-crystal.

COMETS FABRY AND BARNARD.—The brightness of these two comets continues to increase, Fabry's comet in particular promising ere long to be visible to the naked eye; and it seems probable that at the end of April and the beginning of May we may see the unusual spectacle of two bright comets near each other, and very nearly in the zenith.

The following ephemerides are given for Berlin midnight, that for Fabry's comet being by Dr. H. Oppenheim, and that for Barnard's by Dr. A. Krueger:—

Fabry's Comet

1886	R.A. h. m. s.	Decl. ° ′	Log. *r*	Log. Δ	Brightness
Feb. 19	23 21 32	27 13·7 N.	0·0370	0·2058	4·1
23	23 21 0	28 10·6	0·0121	0·1958	4·8
27	23 20 27	29 11·0	9·9860	0·1836	5·7
Mar. 3	23 19 49	30 14·8 N.	9·9591	0·1639	6·9

Barnard's Comet

1886	R.A. h. m. s.	Decl. ° ′	Log. *r*	Log. Δ	Brightness
Feb. 18	2 1 42	18 20·1 N.	0·2017	0·2412	2·9
22	1 59 29	19 20·7	0·1836	0·2426	3·1
26	1 57 39	20 23·4	0·1646	0·2432	3·4
Mar. 2	1 56 8	21 28·4 N.	0·1443	0·2429	3·7

STELLAR PHOTOGRAPHY.—The new nebula around Maia, discovered by means of the photographs taken at the Paris Observatory, has since been seen with the great Pulkova refractor.

M. Cruls, Director of the Rio de Janeiro Observatory, has been commissioned by the Emperor of Brazil to have a photographic apparatus constructed similar to that devised by the Brothers Henry at Paris, in order to co-operate with them in the proposed photographic survey of the sky.

HARVARD COLLEGE OBSERVATORY.—Prof. E. C. Pickering has issued his Report for the year 1885. As in former years, chief interest attaches to the photometric researches carried out at the Observatory. With the 15-inch equatorial the photometric observations of the eclipses of Jupiter's satellites have been continued. In all, 319 eclipses have now been observed, 35 since the end of October 1884. The reduction of the photometric observations of the zone stars between the declinations +0° 50′ and +1° 0′ has been carried on, and the observations of DM. stars between + 49° 50′ and + 50° 0′, as well as those between +54° 50′ and +55° 0′, have been completed. These observations have been made with the wedge photometer attached to the large equatorial. The resulting magnitudes have been computed by means of the stars occurring in the zones which are also under observation with the meridian photometer.

The work of the wedge has thus been made homogeneous with that of the meridian photometer. The extensive use thus made of the wedge photometer seems to show that the instrument used at Harvard College is not capable of the great degree of precision which is claimed for that employed by Prof. Pritchard. To determine whether this difference is due to the form of the instrument, Prof. Pritchard has kindly undertaken to superintend the construction of a wedge photometer made upon his plan. The number of series of observations made during the year with the meridian photometer is 202; the number of separate settings somewhat exceeding 50,000. The accordance of the results continues satisfactory; the average deviation of the separate measures of the standard circumpolar stars being 0·12 of a magnitude. The entire series of stars to be observed with this instrument includes zones at intervals of 5° from the equator to the pole; the system adopted insuring a regular distribution of stars down to the ninth magnitude. An important investigation has also been undertaken in stellar photography. A Voigtlander portrait lens of 8 inches aperture and 44 inches focus has been mounted equatorially, and with this many photographs have been taken of the trails left by a star when the telescope is not driven by clockwork, polar stars as faint as the fourteenth magnitude and equatorial stars of the sixth magnitude having been thus photographed. Some most striking results have been obtained with stellar spectra. By placing a large prism in front of the lens, photographs have been obtained of stars as faint as the eighth magnitude, in which lines are shown with sufficient distinctness to be clearly seen in a paper positive. As all the stars in a large region are thus photographed, more than a hundred spectra have been obtained on a single plate.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 *FEBRUARY* 21-27

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 21

Sun rises, 7h. 4m.; souths, 12h. 13m. 48·0s.; sets, 17h. 24m.; decl. on meridian, 10° 28′ S.: Sidereal Time at Sunset, 3h. 30m.

Moon (at Last Quarter on Feb. 25) rises, 20h. 2m.*; souths, 2h. 17m.; sets, 8h. 19m.; decl. on meridian, 0° 22′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	7 13	12 7	17 1	13 17 S.
Venus	6 1	11 45	17 29	3 51 S.
Mars	18 48*	1 29	8 10	7 24 N.
Jupiter	20 13*	2 15	8 17	0 22 S.
Saturn	11 49	20 0	4 11*	22 44 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		Date	h. m.	
U Cephei	0 52·2	81 16	N.	Feb. 21,	21 38	*m*
				,, 26,	21 17	*m*
Algol	3 0·8	40 31	N.	,, 23,	5 47	*m*
				,, 26,	2 35	*m*
λ Tauri	3 54·4	12 10	N.	,, 22,	20 28	*m*
				,, 26,	19 20	*m*
ζ Geminorum	6 57·4	20 44	N.	,, 27,	21 30	*m*
U Monocerotis	7 25·4	9 32	S.	,, 25,		*m*
S Cancri	8 37·4	19 27	N.	,, 26,	1 54	*m*
W Virginis	13 20·2	2 47	S.	,, 25,	5 0	*M*
δ Libræ	14 54·9	8 4	S.	,, 25,	23 2	*m*
U Coronæ	15 13·6	32 4	N.	,, 26,	22 30	*m*
U Ophiuchi	17 10·8	1 20	N.	,, 21,	3 55	*m*
				and at intervals of	20 8	
W Sagittarii	17 57·8	29 35	S.	Feb. 24,	2 30	*m*
β Lyræ	18 45·9	33 14	N.	,, 21,	2 30	m_2
				,, 24,	7 0	*M*
R Lyræ	18 51·9	43 48	N.	,, 25,		*M*
δ Cephei	22 24·9	57 50	N.	,, 24,	0 0	*m*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Mira Ceti, R.A. 2h 13·6m., Decl. 3° 30′ S., should arrive at maximum about this time, but there seems a little uncertainty as to the precise date. It is possible that it has already passed the maximum. Its spectrum should be examined whilst it remains bright.

Occultations of Stars by the Moon (visible at Greenwich)

Feb.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
21	Uranus	—	5 53	6 34	51 334
23	κ Virginis	4½	1 3	1 20	325 298
25	49 Libræ	5½	2 13	near approach	313 —

Feb.	h.	
21	2	Jupiter in conjunction with and 0° 8′ south of the Moon.
24	16	Mercury in superior conjunction with the Sun.

GEOGRAPHICAL NOTES

LIEUT. WISSMANN, who was on his way back to Europe from his last great journey in the Congo district, stopped at Madeira for the benefit of his health, and has now returned to Africa for further explorations. Lieut. von François, who took part in Lieut. Wissmann's expedition on the Kassai River, has returned to Brussels. He reports that on June 16, 1884, he started with Wissmann from Malange to the Lulua River; thence Wissmann turned northwards and founded the station of Luluaburg, while François investigated the Mukenge district. As he wished to regain Wissmann he built five large boats, in which he reached Luluaburg on the Lulua. He also met Tchingenge, the chief of the Balubas tribe, and Mutenda, one of the first chiefs of the Camokas, who received him kindly. After consulting Wissmann he travelled to the Kassai, which they ascended; then, descending the Congo, they eventually reached Leopoldville, after fifty days' journey. Afterwards François accompanied the missionary, Mr. Grenfell, to the tributaries of the Upper Congo. They first ascended the Lulongo (on the right bank of the Congo), and then the Shuapa, which Stanley names the Uranki. The Shuapa retains its name for the whole length of its course, a circumstance which does not often occur in the Congo lands. It is a large river, navigable everywhere, with extremely fertile banks, which for objects of navigation even surpasses the Kassai. The inhabitants of Batua, on the middle Congo, are a real race of dwarfs. The men have an average height of 1·30 metres, the women of 1·10 metres; but they are well developed and very warlike. When the travellers ascended the river they were attacked by the inhabitants, while on the return journey they were very well received. They also discovered the Bussera, a tributary of the Shuapa. Further on they examined the mouth of the Mobangi, a large tributary of the Congo on its right bank. Grenfell is of opinion that the Mobangi and the Welle River, which has its sources in the Southern Soudan, are one and the same river; François, however, believes that the Mobangi is the continuation of the Nana River, situated further to the north. François states that the land of the Balubas is extremely fertile, no less than three harvests annually being the rule. When exploring the Kassai, François and Grenfell found that this river, instead of joining the Uranki (Shuapa), as Stanley supposed, flows into the Congo near Kwamouth. The Leopold Lake flows into the Kassai at a distance of about 1½° from the Congo. The Lulongo runs parallel to the Congo for a considerable distance on its northern side. The two travellers discovered numerous other smaller tributaries.

A RECENT number of *Cosmos* contains an article by M. de Morgan, who was employed by the Government of the Straits Settlements to prepare a map of the State of Perak in the Malay peninsula, on the Stone Age there. In the course of his work, the writer had to visit the range of mountains forming the watershed of the peninsula, and here came into contact with the Sakayes, Seumangs, Rayats, and other pre-Malay Negrito tribes, as nearly in their original state as they can now be found in these regions. He refers to other tribes living in recesses of the mountains, of whom he learnt from the Sakayes. The latter call them "fire apes"; their language is said to have nothing in common with Malay or Negrito dialects. M. de Morgan received here two polished stone axes, which were said to be made by the "fire apes." One was made of a fine-grained yellow porphyry, and was 224 mm. in length, 53 mm. in breadth, and 16 mm. thick; the other was of a green quartz schist, and

was smaller in size. They were polished with great care, and in shape resembled certain Scandinavian stone axes. From inquiries which he made, he came to the conclusion that in recent times there existed in the centre of the Malay peninsula a people wholly ignorant of metals, and he asks whether these "fire apes" are a remnant of the aborigines, who were overwhelmed by a Negrito invasion, or whether they are merely Sakayes who fled before the Malays. The Sakayes, it should be noted, preserve a tradition of the use of stone implements, and it is probable that before the Malay invasion they knew nothing of metals. It is curious to notice that the Malays, who frequently find stone axes in the soil, called them "thunderstones," believing that they proceed from a thunderbolt, thus reproducing an old Breton notion in the centre of the Malay peninsula.

WE have more than once referred to the extraordinary diversity and confusion of the names of States and towns in the eastern half of the Indo-Chinese peninsula. The Marquis d'Hervey de Saint-Denys, well-known for his Chinese researches, has recently read a paper on this subject before the Paris Academy of Inscriptions, which throws much light on the history of this nomenclature. In the sixth century of our era the Chinese, regarding the populations of the present Kuantung, Kwangsi, and Tonquin as barbarians, called them Yuen. When the present Tonquin was conquered and reduced to a Chinese province, they called it Kiao-chi or Kia chow, from the name of the capital, the Hanoi of our days. In 756 they established in Tonquin a great district, which they styled the Annam, or "pacificator of the south." This is the origin of the present designation. In the fifteenth century Annam, then become a feudatory kingdom, was divided into two principalities: the Western Court, Si-tong, and the Eastern Court, Tonquin; hence the latter name. In 1775 the kingdoms of Annam and Cochin China were destroyed by a rebellion, and the last king of the former died at Pekin, whither he had fled. The King of Cochin China, however, succeeded in recovering his throne, and in adding, with the consent of the Chinese, Annam to his dominions. But, in ratifying this union, the Emperor of China bestowed a new name on the whole, Yue-nan. The writer concludes that the country called Annam by the Chinese never went beyond the seventeenth parallel of latitude, and that in every document in which the title occurs the present Tonquin is really meant. It would thus appear that there are, historically, only two countries on the east coast of the peninsula, viz. Annam (which is Tonquin, and nothing more) and Cochin China. But this leaves the present Annam to be accounted for. Possibly nothing short of an International Geographical Congress will succeed in producing a simple uniform nomenclature for this region.

THE *Revue Scientifique* bases the following conclusions on the climate of Tonquin on the evidence given by medical and sanitary experts before the recent Commission of the French Chamber on the subject. Compared with Cochin China, Tonquin is not unhealthy; from September to April there is regular spring, and it is from May to October that the heat is almost insupportable. Except in the mountains, which are dreaded by the natives, and in the forests in the neighbourhood of Hung-hoa, there are no deadly fevers as in Cochin China; especially are there no serious diarrhœas as in the latter. In the delta of the Red River, cultivation and vegetation render it healthy. It is doubtful whether cholera is endemic in Tonquin; the last epidemic appears to have been imported from the Pescadores, and it attacked natives rather than Europeans. But sunstroke is rather prevalent. Two years is the limit assigned for the residence of troops having to undergo great fatigue, with an insufficient quantity of good food; but on occasion this stay may be prolonged without harm to three or four years. Merchants and officials may safely spend fifteen to twenty years in the country.

AT the meeting of the Geographical Society of Paris on January 8, M. Duveyrier described some observations made at Tuggurt in 1860, from which he calculated the latitude at 33° 7′ 0″ and the longitude at 3° 36′ 24″ east of Paris. M. Le Chatelier sent several notes relating to the southern part of Algeria.

THE *Compte rendu*, No. 1, 1886, of the Paris Geographical Society, contains a suggestion from M. Alphonse de Candolle referring to the want in geographical books and works of travel of an analytical index. These works, he says, contain information on natural history, agriculture, mines, ethnography, language, arts, religion, &c., which interest all classes of students, but it is scattered throughout the various works, and few have the patience or the time to get at them by an attentive perusal of the whole. He has often experienced this want himself in preparing his botanical geography, and more recently the work on the origin of cultivated plants. As models of indices he points to Darwin's works, and adds that the more detailed the index is the better. He therefore invites the Society to encourage the addition of indices to geographical works.

THE last *Bulletin* (No. 4, 1885) of the same Society contains the full text of M. Velain's geographical and ethnographical sketch of French Guiana, and the basins of the Yari and Paru, affluents of the Amazon, based on Dr. Crevaux's exploration; of M. de Saint-Pol Lias's account of his journeys in Sumatra and Malacca ("Atché and Pérak"); and of the journeys of MM. Senèze and Noetzli in Ecuador and Peru in 1876-77.

Globus (No. 5, 1886) contains an article by Prof. Blumentritt on the tribe of Guinaus of Abra, in Luzon, based on a communication by Lieut. Trullens, of the Spanish Army, to the *Boletin* of the Philippine Society of the Amigos del Pais. The article describes the houses, mode of life, manners and customs of the tribe. They are confirmed head-hunters, notwithstanding the presence of Spanish troops and police in their territory. Their superstitions, Prof. Blumentritt says, go to strengthen the theory that the religious notions of the Malays all over the Archipelago are broadly the same. It is noteworthy that he laments the general ignorance of ethnology displayed by most Spanish writers on the Philippine races.

THE LUMBAR CURVE IN MAN AND APES[1]

IN this investigation the fresh spines of twelve Europeans, of four anthropoids, of fifteen different species of the lower apes, and several quadrupeds were examined. In each case the body was frozen, and then divided by a saw in the mesial plane. When still in the frozen condition a tracing was taken of the outline of the body, and of the centra of the vertebræ. The results obtained all tend to minimize the importance of the lumbar curve as a distinctive character of any special group. It is present in a well-marked form not only in the chimpanzee, but also in most of the lower apes, and even, under certain conditions, in some quadrupeds (*i.e.* bear). In the chimpanzee the quality of the curve is identical with that of man: it only differs in degree. The latter point could not be absolutely determined, as the four anthropoids examined were little over four years old, and yet the degree of curve was much greater than that of a child of six—indeed it was comparable with that of a child of thirteen.

The second part of the memoir dealt with the adaptation in form of the vertebral bodies to the lumbar curve. By measurements it can be established that in the low races the lumbar curve is not stamped upon the spine so firmly as in the case of the Europeans. In other words, the European lumbar vertebræ are moulded in accordance with the curve, whilst the corresponding vertebræ of the low races are not.

Taking the anterior vertical depth of each vertebral body as 100, the following indices were obtained:—

MAN

		76 Europeans	17 Australians	3 Tasmanians	3 Bushmen	23 Andamans	10 Negroes
Five lower true vertebræ	*a*	106·1	119·8	115·1	115·9	112·6	113·5
	b	101·4	113·	109·9	113·4	111·2	111·3
	c	97·2	113·6	110·1	109·9	108·1	105·9
	d	93·5	103·9	109·5	100·8	102·6	105·1
	e	81·6	90·4	92·4	95·3	91·4	92
Average index		95·8	107·8	107·2	106·6	104·8	105·4

[1] Abstract of a Paper on "The Lumbar Curve in Man and the Apes, with an Account of the Topographical Anatomy of the Chimpanzee." By D. J. Cunningham, M.D. (Univ. Dub.), Professor of Anatomy in Trinity College, Dublin. Read before the Royal Irish Academy, January 26, 1886.

		5 Gorillas	9 Chimpanzees	4 Orangs	6 Gibbons	2 Baboons	3 Macaques	1 Colobus
		Ape						
Five lower true vertebræ	*a*	115·3	125·3	113·7	112·8	117·7	109·7	103·8
	b	111·7	117·1	118·9	108·8	120·6	107·8	103·8
	c	111·3	116·4	119·7	107·5	108	103	103·8
	d	105·3	116·1	111·9	106·4	107·3	103·2	108
	e	101·9	115·8	103·5	104·1	92·8	96·2	90·4
Average index		108·1	117·5	112·9	107·1	108·5	103·7	102·4

It can be proved in many ways that the lumbar curve of the spine is more marked in the human female than in the male. The methods adopted for the elucidation of this point were: (1) tracings of mesial sections of the frozen spines of the two sexes; (2) Measurements of the anterior and posterior surface of the lumbar region; and (3) measurements of the individual lumbar vertebræ.

The difference between the indices of the vertebræ of the two sexes are not confined to Europeans, but are also observed in four of the five lower races examined, as will be seen from the following table :—

	Irish		Andamans		Negroes	
	21 ♂	23 ♀	14 ♂	9 ♀	7 ♂	3 ♀
Average index of the five lumbar vertebræ ...	96·2	93·5	106·3	102·4	106	103·4

	Australians		Tasmanians	
	10 ♂	4 ♀	2 ♂	1 ♀
Average index of the five lumbar vertebræ ...	110·1	103·1	108·5	104·7

It can be shown that the indices of the lumbar vertebræ of a given European spine are in strict accordance with the degree of lumbar curve. But, whilst this is the case, the difference between the anterior and posterior vertical diameters of the vertebral bodies is so slight (as Weber has observed) that it can have little effect in producing the lumbar curve. The form-adaptation of the vertebral bodies must, therefore, be regarded as the consequence, and not as a cause, of the curve: at the same time it cannot be due to an immediate and mechanical influence operating upon the vertebral bodies during the life of the individual. If it were so, the same characters would be present in the lumbar vertebræ of the low races, and even of the anthropoid. It is an hereditary condition.

The European, who leads a life which rarely necessitates his forsaking the erect attitude except as an intermittent occurrence, and then for short periods, has sacrificed in the lumbar part of the vertebral column *flexibility* for *stability*. It is evident that the deeper the bodies of the vertebræ grow in front, the more permanent, stable, and fixed the lumbar curve will become, and the more restricted will be the power of forward-bending in this region of the spine. The savage, in whose life agility and suppleness of body are of so great an account, who pursues game in a prone position, and climbs trees for fruit, &c., preserves the anthropoid condition of vertebræ, and in consequence possesses a superior flexibility of the lumbar part of the spine.

SNOW-COVERING AND THE WEATHER

DR. WOEIKOF, who is one of the meteorologists of the modern school, has long entertained a deep conviction that meteorology ought not to limit itself to a mere observation of those few instruments which for nearly fifty years have constituted the plant of meteorological Observatories. In the development of its general laws and the application of them to forecasts of weather, it must widen the circle of its observations, and take into account those factors upon which weather and climate depend in each given locality. For the past fifteen years he has devoted his time to the study of local climates and their dependence upon local causes, such as the local deflections of the paths of cyclones and anticyclones; the proximity of seas, steppes, marshes, and forests, and the local heating and cooling of the ground. His chief work, published in Russian, entitled "The Climates of the Globe," is most valuable, on account of the wide knowledge it evinces of the various circumstances on which climate depends, especially with regard to the immense plains of Russia.

The influence of the snow on climate, of its depth and consistency, the time of its first appearance and disappearance, the evaporation from its surface, the purification of air when it has fallen, and a variety of minor circumstances, the importance of which has been insisted on by Dr. Woeikof since 1872, are all referred to. Unhappily, observations on snow are very few and imperfect, and in a paper recently read before the Russian Geographical Society, and now printed in its *Memoirs* (xv. 2), he returns to the subject, illustrating the importance of such observations by a few well-chosen examples.

The year 1877 was a striking instance of how the absence of snow was accompanied by a far less notable lowering of temperature during the prevalence of anticyclones than would have been the case had the soil been covered with snow. In 1877 there was no snow in Eastern Russia until Christmas, and in November and December the anticyclones occurred, accompanied by no wind, or only by feeble breezes. Quite bright weather lasted in December for more than ten days; and still in the region which remained uncovered with snow no great cold was experienced as usually happens in such circumstances: the minima were 8° to 9° above their average values. The same conditions were noticed during the winters of 1879-80 and 1881-82, in West Europe, as shown by Dr. Billwiller in the *Zeitschrift für Meteorologie* for 1882.

In Dr. Woeikof's opinion the relatively high mean temperature of November, as compared with March, in South-East Russia and the Kirghiz Steppe may be explained by the circumstance that in these localities the soil usually is not covered with snow in November; and thus, not being separated from the air by the snow, which is a bad conductor of heat, it rather contributes to maintain a higher temperature in the air resting on it. On the other hand, towards the end of winter the surface is much cooled and exercises a refrigerating influence on the air. Examples from the United States adduced by M. Woeikof seem also to confirm this view.

The refrigerating influence of a thick covering of snow in the spring and the influence it exercises in retarding the arrival of warm weather is so obvious that it need not be insisted on. A paper was written by M. Woeikof, in 1872, on this subject; and the very interesting illustrations he has adduced to show the refrigerating influence of a snow-covering during years when snow was abundant, are very striking. He has since returned to this subject in his "Climates of the Globe," and in the paper we mention; and we may consider it quite established that it is precisely to this agency that the relative coolness of the spring months in Russia and Siberia is due. Moreover, it may be considered as certain that when the snow-covering has been thick, and especially when the snow has a harder consistency, the arrival of warm weather will come on late in the spring.

Another result which Dr. Woeikof has established relates to the commencement of first durable frosts. As long as there is no snow, or little, he argues that frosts may begin, but they will not be durable, and the temperature may rise above the freezing-point; but it is the snow-covering, although not very thick, which gives durability to cold weather. It is easy to foresee how important it becomes, in forecasting the weather, to know, both in spring and autumn, if there are, to the north and east of any region, broad spaces covered with snow.

It is useless to insist upon the importance of an exact knowledge of the depth and consistency of the snow for forecasts in the interests of navigation, especially in countries like Russia, where navigation on so many rivers is carried on only at high water. Several interesting illustrations of this influence are given by the author. In view of these important results, it is

mo t desirable that all observations regarding snow should be made part and parcel of regular meteorological observations. The Ural Society of Naturalists has already collected valuable materials under that head, and it may be assumed that scientific and practical meteorologists will not be slow in taking advantage of such observations. P. K.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Mr. S. F. Harmer, B.A., has been appointed Demonstrator of Animal Morphology, in the place of Mr. Walter Heape, resigned. Mr. Harmer was previously Demonstrator of Comparative Anatomy.

The subject for the Sedgwick Prize Essay in 1889 is the Petrology of the Igneous Rocks associated with the Cambrian (Sedgwick) of Carnarvonshire. The essays must be sent in on or before October 1, 1888. It is open only to graduates of Cambridge who have resided sixty days during the year preceding that date.

On the 22nd inst. the General Board of Studies will proceed to nominate a University Lecturer in Geology for five years, in the place of Dr. R. D. Roberts, now Secretary to the London Association for the Extension of University Teaching.

A report of the General Board of Studies has been carried, recommending that no fees shall be paid by students to Professors and Readers in consideration of the lectures which form part of the ordinary duty of their office, but only for further assistance and material or apparatus; also that a return shall be given to the Board of lectures delivered, extra teaching given, and fees charged.

The important proposals respecting the additional subjects in the Previous Examination required of candidates for honours have been carried in such a way as to make them broader in their effects. The substitution of Mechanics for Statics was carried by 58 to 44. The alternative of French or German was introduced by 59 to 42; and then, somewhat surprisingly, the restriction of this alternative to candidates for the Mathematical Tripos, and the requirement that candidates for any other tripos than the Mathematical should pass in the mathematical additional subjects, were rejected by 53 to 49. Thus a great step in advance is made, and any candidate for honours can take Mathematics, French, or German as an additional subject.

Mr. Leslie Stephen has been reappointed an Elector to the Knightbridge Professorship, Lord Rayleigh to that of Chemistry, Mr. Christie, Astronomer-Royal, to the Plumian Professorship; Dr. Humphry has been appointed an Elector to that of Anatomy in place of the late Dr. Allen Thompson; Mr. F. Darwin has been reappointed an Elector to that of Botany; Dr. G. J. Hinde has been appointed an Elector to the Woodwardian Professorship of Geology in place of Rev. E. Hill; Prof. Stokes, P.R.S., has been reappointed an Elector to the Jacksonian Professorship; Dr. H. C. Sorby, F.R.S., to that of Mineralogy; the Right Hon. G. J. Goschen, M.P., has been appointed an Elector of that of Political Economy, in place of Prof. A. Marshall; Prof. H. N. Moseley, F.R.S., has been reappointed an Elector to that of Zoology and Comparative Anatomy; Prof. Stokes, P.R.S., to the Cavendish Professorship; Lord Rayleigh to that of Mechanism; Dr. F. J. Farre to the Downing Professorship of Medicine; Prof. Huxley to that of Physiology; Sir James Paget to that of Pathology; Prof. William Wallace has been appointed an Elector to that of Mental Philosophy and Logic, in place of Mr. James Ward; and Mr. Cadge to that of Surgery. The appointments in each case are for eight years.

The report recommending the institution of a Tripos Examination in Engineering, to be combined to some extent with the Natural Sciences Tripos, has been discussed at some length in the Senate. Mr. Hill thought parts of the Mathematical Tripos and the Special Examination of Engineering sufficient. Mr. Trotter throught the proposed examination was required both for engineering students and students of physics. It was desirable to increase the mathematical training of students of engineering. The Mathematical Tripos had, he thought, suffered from its long and illustrious history. The Examiners felt bound to find something new, and a good deal of students' time was spent in recognising old things in disguised forms, and in solving mathematical puzzles, not suitable for an engineering student pressed for time, or for a student of experimental physics. Prof. Stuart said he was in a position to state that the University had now the opportunity of making its engineering certificate very much ahead of anything else in the world. In one very important respect the new examination would differ from the Mathematical Tripos; it would include practical work in its earliest part.

NEW science buildings are now being erected for Tonbridge School at a cost of nearly 14,000*l*. They will contain chemical and physical laboratories, lecture-room, class-rooms, preparation-rooms, and in addition a library and room for drawing.

SCIENTIFIC SERIALS

The Journal of the Royal Microscopical Society for December 1885 contains:—On some new and rare Desmids, by W. Barwell Turner (plates 15 and 16). Describes a number of new species, for the most part from the United States of America, but the localities are not always very definitely given. A new genus, Leptozosma, is made for a filamentous form near to Bambusina, Kütz, but differing in the sutures. The various forms mentioned are all figured.—Further experiments on feeding insects with the curved or "comma" Bacillus, by Dr. R. L. Maddox. The curved Bacilli are apparently able to retain life in the intestinal tract of flies, and so might possibly become a source of injury to animals.—On the cholera "comma" Bacillus, by G. F. Dowdeswell, M.A.—On an improved form of Stephenson's binocular prisms, by C. D. Ahrens.—Remarks on Prof. Abbe's note on the proper definition of the amplifying power of a lens or lens-system, by Dr. E. Giltay.—On the limits of resolution in the microscope, by Frank Crisp, LL.B., with a note by Prof. Abbe.—The usual summary of current researches and the proceedings of the Society.—At one of the meetings Mr. Crisp exhibited a series of photographic portraits of all the Presidents of the Society. These—eighteen in number—appear in the present part, arranged on two plates of eight portraits each and two full-page portraits of Sir R. Owen, the first President of the Microscopical Society, and of Mr. Glaisher, the first President of the Royal Microscopical Society.

Wiedemann's Annalen, Bd. xxvii. No. 1, January.—F. and W. Kohlrausch, the electro-chemical equivalent of silver, together with an experimental proof of the measurements of intensity of terrestrial magnetism. These determinations, chiefly by the method of Joule, appear to have been made with the utmost regard for precision in all details. The value of the electro-chemical equivalent of silver deduced is about 0·06 per cent. higher than that given by Lord Rayleigh, being 0·001183 gramme per ampere, as against 0·0011179. Mascart's latest value was 0·0011156. This would make the equivalent of hydrogen 0·000010386.—A. Kundt, on double refraction of light in metal films which are produced by disgregation of a cathode. Films deposited by electric discharges from a pointed cathode show a circularly-arranged dichroism when viewed in the polariscope.—Ch. Lüdeking, on the specific heats, specific gravities, and heats of hydration of the fatty acids and of their mixtures with water.—Otto Schumann, on the density of the adsorbed films of air on surfaces of glass.—J. Lahr, Grassmann's vowel-theory in the light of experiment. Discusses the results obtained by Jenkin and Ewing with a phonograph, and by Schneebeli with a phonautograph.—E. Aulinger, on the relation of Weber's theory of electrodynamics to the principle of unity of electric forces propounded by Hertz.—O. Tumlirz, on the properties of rock crystal in the magnetic field. This paper announces the discovery in this body of residual diamagnetic properties.—Eug. Blasius, notice on Japanese mirrors. Describing kindred phenomena with glass plates which have been scratched at the back with a writing diamond.—E. Lommel, aërostatic balance for the determination of the specific gravities of gases.

Archives Italiennes de Biologie, tome vi. fasc. 3, May 30, 1885.—This part completes volume vi. of this *Archiv*, and in it the editors apologise for its tardy and irregular appearance, which was caused by the terrible epidemic which afflicted Italy in 1884. For the future the *Archiv* will appear not at stated periods, but as matter is ready for publication, every three parts to form a volume. This part contains the last part of a notice of Dr. Beccari's work on "Piante Ospitatrici," by M. E. Levier. These host plants, noticed first by Rumphius in 1750, have been studied in New Guinea and in the Malay Archipelago by Beccari, the first part of whose deeply interesting account of them and their ant guests has but recently been published.—On a case of congenital cataract, by J. Albertotti. The patient was operated on at the age of 21. The operation

was a brilliant success, and the experiences noted in this paper are of great value; but the result to the patient may be guessed at by his exclamation some months after the operation: "C'était mieux quand je ne voyais pas."—On the action produced on the sensibility and motility of nerves by dilute hydrochloric acid, by Dr. C. Negro.—Note on pneumonococcus, a grave complication in pneumonia, by P. Foa and G. Rattone.—On the physio-pathological aspects of stratified pavement epithelium, and on the pathogeny of albuminuria, by Prof. G. Tizzoni.—On the presence of albumen in saliva, a criticism of the views of Madame Dessales by Prof. Brancaccio, and a reply by Madame Dessales.—On the central termination of the optic nerve in some mammals, by Dr. J. Bellonci.—On the influence of chloral on gastric digestion, by A. Fiumi and A. Favrat.—Anatomical and clinical study of Morgagni's cataract; and on congenital micro-ophthalmy, by Dr. Falchi.

Rivista Scientifico-Industriale, December 15–31.—Dr. Pietro Cardani, variation of the diameter of the sparks with the potential and the resistance: a study of the way the diameter of the sparks is modified by the resistance of the circuit, and how the diameter itself varies with the increase of the explosive distance. The diameter is found to increase proportionately to the square root of the potential, and to decrease according to a hyperbolical function with the increased resistance; hence for great distances this diameter becomes sensibly constant. The same physicist deals with Harris's second law that the explosive distance varies inversely with the pressure of the gas, and concludes that this law is true only within certain limited conditions.—Dante Roster, remarks in connection with Prof. Mariacher's observations on the food of birds. These studies have a practical value, tending to determine those birds which are insectivorous, and consequently harmless, and those that are graminivorous and injurious to the crops.

Reale Istituto Lombardo, January 7.—Summary of Tito Vignoli's monograph on "The Psychic Act of Attention in the Animal Series," in which the author describes the genesis of attention from the lowest to the highest organisms, analysing the elements of sensation and perception, and determining their comparative values. The physiological and psychological conditions of attention are held to be identical in the higher animals and in man, differing only objectively, and man alone being capable of introspective thought. Hence man is distinguished from other animals, not by the physio-psychic act of attention, but by the faculty of submitting his own intelligence to examination.—In a supplementary note on the transition from animal to human intelligence, Vignoli argues that Darwinism will never succeed in explaining the evolution of the organic from the inorganic, nor of sensation and consciousness from the mere organic. The passage from the intelligence of animals to that of man is not a gradual development of the faculties, but is accomplished by a reflex act of animal intelligence on itself. This act must be instantaneous, consequently is not the result of evolution, as are the physical conditions leading up to it.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 7.—"Experimental Researches on the Propagation of Heat by Conduction in Muscle, Liver, Kidney, Bone, and Brain." By J. S. Lombard, M.D., formerly Assistant Professor of Physiology in Harvard University. Communicated by Charles E. Brown-Séquard, M.D., LL.D., F.R.S.

January 14.—"Notes upon the Straining of Ships caused by Rolling." By Prof. Francis Elgar, LL.D., F.R.S.E

It does not appear that any serious attempt has yet been made to investigate the amounts, or even the nature, of the principal straining actions which the rolling of a ship brings into play, or of the effect of those straining actions upon the material of which the hull is composed. Various writers, from Bouguer in 1746, down to Prof. Macquorne Rankine in 1866, and Sir E. J. Reed in 1871, have discussed the straining actions that are caused by longitudinal racking and bending when a vessel is floating in statical equilibrium. Sir E. J. Reed elaborately investigated the subject in a paper contained in the *Philosophical Transactions* of the Royal Society for 1871, and gave examples of the amounts and distribution of the stresses caused by such straining actions in several typical ships of Her Majesty's Navy. Mr. W. John supplemented this by a paper on the strength of iron ships, read before the Institution of Naval Architects in 1874, in which similar results were given for various classes of vessels in the mercantile marine.

The later investigations of these longitudinal straining actions apply not only to the case of a ship floating in equilibrium in still water, but also to cases in which she is (1) in instantaneous statical equilibrium across the crest of a wave; and (2) in instantaneous statical equilibrium across the hollow of a wave—the wave-length being equal to the length of the ship.

Cases frequently occur which show that the maximum stresses of the material of a ship's hull are not in proportion to the results obtained by the ordinary calculations; and that certain deductions that have been drawn from those results are by no means sound. For instance, it is said to follow from the analogy between the longitudinal bending action upon a ship afloat and that upon a loaded girder, that there is little or no stress exerted upon that portion of a ship's plating which is in the vicinity of the neutral axis for the upright position; and the inference has been drawn that, subject to the consideration of the sides being occasionally brought, in some degree, into the positions of flanges of a girder at large inclinations, the thickness of the material may be decreased with advantage near the neutral axis. Now it cannot be shown that the plating which is in the vicinity of the neutral axis when the ship is upright, is ever brought into such a position by the rolling of a vessel as to be much affected by mere longitudinal bending.

Other propositions respecting the distribution of stress in various parts of the structure have been deduced from considerations and assumptions upon which the ordinary calculations of longitudinal strength are based; and rules have, in consequence, been proposed for regulating the strength of the principal component parts of ships' hulls. It is only necessary here to say that many of those deductions, like the one already noticed, are unsound, and are not consistent with the effects that may be observed of straining action at sea.

A considerable experience at sea, where the author has closely observed the effects of straining action caused by twisting moments, and a further experience in investigating the stresses to which the various portions of ships' hulls are subjected according to the theories referred to, and in comparing the results so obtained with the visible evidences of straining action, have convinced him that the stresses caused by twisting moments are much greater than is generally supposed, and that no rules for regulating the strength of ships can be satisfactory if based upon hypotheses that exclude all practical consideration of twisting moments.

The straining action considered in this paper is that caused by the twisting moments which operate when a ship rolls from side to side, and which are caused by differences in the longitudinal distribution of the moments of the forces that cause rotation, and those which resist rotation.

After describing at length the manner in which the twisting moments may be approximately calculated, the author proceeds to consider the amounts and distribution of the stresses upon the material of the hull which are caused by a given twisting moment:—

We can learn something of the nature and distribution of those stresses; but, at present, their amounts cannot be calculated with any reliable approach to accuracy. Experiments are required upon the torsion of thin shells of various prismatic forms in order to furnish the requisite data for dealing with so complicated a case as that of a ship's hull. The difficulty of obtaining exact data is very great; but attention is drawn to some of the general considerations which affect the twisting moments and the distribution of the twisting strains and stresses over a ship's hull; and to the bearing which these have upon the important practical problems that relate to the structural strength of ships.

The best data available for guidance in judging of the distribution of strain and stress due to twisting over the structure of a ship are to be found in M. de Saint-Venant's investigations of the torsion of prisms.[1]

The distribution of the torsional stresses over the transverse section of a ship's hull is obviously different from the distribution

[1] "Mémoires présentés par divers Savants à l'Académie des Sciences de l'Institut Impérial de France," tome 14, 1856. "Mémoire sur la Torsion de Prismes, &c." Par M. de Saint-Venant," pp. 233-560. Also Thomson and Tait's "Natural Philosophy," vol. i., part 2, secs. 699-710.

of the stresses due to longitudinal bending. The parts subjected to greatest stress by twisting are those which are near to the centre of gravity of the transverse section; and they are the side plating near the neutral axis of longitudinal bending in the upright position and the middle portions of the plating of the decks. Those parts of the hull which are usually made the strongest, viz., the strakes of side and bottom plating that are farthest from the neutral axis, and the upper deck stringer plate, are those which are least affected by twisting. It is probably owing, in great measure, to the straining action caused by twisting, that experience has proved it to be necessary to make the outside plating of a ship of nearly uniform thickness over the whole section; and it cannot be because of the reason sometimes given, that the plating in the vicinity of the neutral axis when a ship is upright is often brought by rolling into positions in which it is greatly strained by longitudinal bending.

The importance of many of the structural arrangements of ships which practical experience has shown to be necessary are described in the present paper, and may be understood from the considerations adduced; and it may also be seen that no rules for regulating the strength of ships are likely to be satisfactory if based, as is often done, upon the hypothesis that the straining actions caused by longitudinal bending are so much more important than all others that it is sufficient to regard them alone.

Abstract of Paper on "Proteid Substances in Latex." By J. R. Green, B.Sc., B.A., Demonstrator of Physiology in the University of Cambridge.

The author, after calling attention to the researches of other writers into the nature of the proteids found especially in seeds, described certain bodies found by him to be present in the latex of various plants, chiefly East Indian and South American. The most noteworthy of these was a curious proteid exhibiting relations to the peptones and to the albumoses, resembling the former in being soluble in distilled water, in not being coagulated by heat, and in dialysing through membranes, and agreeing with the latter in being precipitated from its solutions in saturation with solid neutral salts. In addition to this body, which was present in all the samples examined, others were described, including a form of albumen, a globulin, and two albumoses, one of the latter being identical with the hemi-albumose described by Vines as occurring in many seeds. The paper concluded with a recapitulation of the bodies found, and with a detailed summary of their distinguishing reactions.

February 4.—"On Intra-vascular Clotting." By L. C. Wooldridge, M.B., D.Sc. Communicated by Prof. Sanderson.

The author has isolated from the perfectly fresh thymus gland and testis of the calf a substance which, when dissolved in alkaline salt solution and injected into the blood of an animal, causes instantaneous death.

The substance in question is a complex proteid body, and as proof that the effects it produces are due to this proteid and not to any accidental admixture, the author adduces the fact that it becomes entirely inactive after having been subjected for a short time to the action of artificial peptic digestion.

The cause of death is extensive intra-vascular clotting of the blood; if a sufficient quantity be injected, complete thrombosis of the whole vascular system is produced. The substance does not contain any fibrin ferment, nor does the blood which is obtained from an animal after injection of this substance contain more than a minute trace of ferment.

Mathematical Society, February 11.—Mr. J. W. L. Glaisher, F.R.S., President, in the chair.—Prof. P. H. Schoute, Ph.D., Groningen, Netherlands, was elected a Member.—Capt. P. A. Macmahon, R.A., read a paper on perpetuant reciprocants, the object of which was to present the numerical enumeration of the perpetuant reciprocants of the first six degrees carried out on the plan initiated by Prof. Sylvester (see NATURE, January 7, p. 222, *Comptes rendus*, and the *Messenger of Mathematics*).—The President communicated a note on the functions $Z(u)$, $\theta(u)$, $\pi(u,a)$ by himself, and a note on a $Z(u)$ function by Mr. J. Griffiths.—The Secretary read part of a paper by Mr. R. A. Roberts on polygons circumscribed about a conic and inscribed in a cubic.

Anthropological Institute, January 26.—Anniversary Meeting.—Mr. Francis Galton, F.R.S., President, in the chair.—The following gentlemen were elected Members of the Council for the ensuing year:—President, Francis Galton, F.R.S.; Vice-Presidents: John Beddoe, F.R.S., Capt. R. F. Burton, Prof. G. Busk, F.R.S., John Evans, F.R.S., Prof. Flower, F.R.S., Prof. Huxley, F.R.S., Sir John Lubbock, Bart., F.R.S., Major-General Pitt-Rivers, F.R.S., Edward B. Tylor, F.R.S., Hyde Clarke, Lieut.-Col. H. H. Godwin-Austen, F.R.S., Prof. A. H. Keane; Secretary, F. W. Rudler, F.G.S.; Treasurer, F. G. H. Price, F.S.A.; Council: S. E. B. Bouverie-Pusey, Sir W. Bowman, Bart., E. W. Brabrook, F.S.A., Sir George Campbell, C. H. E. Carmichael, M.A., W. L. Distant, A. W. Franks, F.R.S., J. G. Garson, M.D., A. L. Lewis, Prof. A. Macalister, F.R.S., R. Biddulph Martin, Prof. Meldola, Prof. Moseley, F.R.S., C. Peek, M.A., J. E. Price, F.S.A., Charles H. Read, F.S.A., Charles Roberts, F.R.C.S., Lord Arthur Russell, Prof. G. D. Thane, M. J. Walhouse, F.R.A.S.

Entomological Society, February 3.—Mr. R. McLachlan, F.R.S., President, in the chair.—The President appointed Mr. F. Du Cane Godman, F.R.S., Mr. Stainton, F.R.S., and Mr. J. Jenner Weir, Vice-Presidents for the year.—Dr. Livett, Lieut. Goodrich, Mr. Eustace Bankes, and Mr. F. Enock were elected Fellows, and M. Ragonot of Paris, ex-President of the Entomological Society of France, was elected a Foreign Member.—Mr. C. O. Waterhouse exhibited some cocoons of *Coccidæ* (*Eriopeltis*) found by Mr. Moore on blades of grass at Ilfracombe.—Mr. Douglas sent for exhibition leaves of *Euonymus japonicus*, received from M. Lichtenstein, infested by a coccid, *Chionaspis euonymi*, first noticed in the United States, but which occurred in great numbers at Montpellier and Nismes, and always destroyed the shrubs attacked by it.—The President exhibited specimens of *Tettix australis*, received from Mr. Oliff of the Sydney Museum, who had captured them near Penrith, New South Wales. Mr. Oliff stated that the insects were decidedly sub-aquatic, as he had found them 8 or 10 inches below the surface of the water on the stems of water plants.—Mr. W. F. Kirby exhibited, on behalf of Mr. Ralfe, a series of specimens of *Lycæna corydon* of a very extraordinary character.—The Rev. W. W. Fowler exhibited a specimen of the almost unique beetle, *Harpalus calceatus*, taken by himself at Bridlington; also a specimen of *Apion Lemoroi*, a new French *Apion* taken on the coasts of Normandy and Brittany. He also exhibited several species of British *Helophori*, and read notes on their synonymy.—Mr. H. Goss read an analysis of M. Brongniart's recent work on "Les Insectes fossiles des Terrains Primaires," and expounded that author's views on the classification of insects from geological data.—The Rev. W. W. Fowler read notes on a small collection of *Languriidæ*, with descriptions of two new species.—Dr. Baly communicated a paper containing descriptions of new genera and species of *Galerucidæ*.—Mr. J. Edwards communicated the first part of a synopsis of British *Homoptera* (*Cicadina*).

Institution of Civil Engineers, January 26.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was on the injurious effect of a blue heat on steel and iron, by Mr. C. E. Stromeyer, Assoc.M.Inst.C.E.

MANCHESTER

Literary and Philosophical Society, December 1, 1885.—Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.—The diffraction of a plane polarised wave of light, by R. F. Gwyther, M.A.—On the different arrangements of equal spherical granules, so that the mean density may be a maximum, by Prof. Osborne Reynolds, F.R.S.

DUBLIN

Royal Society, January 20.—Section of Physical and Experimental Science.—C. R. C. Tichborne, Ph.D., in the chair.—On a nomenclature for facilitating the study of music, by G. J. Stoney, D.Sc., F.R.S.—Notes on improvements in equatorial mountings, by Howard Grubb, M.E., F.R.S. These consisted of a new slow motion in declination, a new position finder, and a modification of the old differential slow motion in right ascension. Mr. Grubb also described a new slow motion in right ascension, and a new arrangement for electric clock control specially adapted for celestial photography.—Dr. Stoney communicated notes on observations made by Prof. Vogel with the great Vienna refractor.—On a method of determining the specific gravity of a small quantity of a dense solid, also applicable to finding the specific gravity of a small quantity of a porous substance, by J. Joly, B.E. The ordinary method of dealing with

minute fragments of minerals, by balancing in a liquid of a specific gravity adjustable to that of the mineral, fails altogether (*a*) when the substance has a specific gravity over 4·5 about; (*b*) when it is of a porous nature. The author deals with minerals having a specific gravity above that of Thulet's solution, or of a porous nature, by embedding a known weight of the mineral in a known weight of paraffin of known specific gravity, and then determining the specific gravity of the mixed bodies by balancing in a solution of low density. From these data the required specific gravity is calculable. Several experiments carried out on fragments of heavy or dendritic minerals ranging in quantity from 12 to 35 milligrames were quoted. These gave results concordant with recorded densities, and, where carried out on pieces removed from the same hand specimen, were uniformly consistent.—Celestial phenomena explicable by meteors, by W. H. S. Monck, M.A.

Section of Natural Science.—J. P. O'Reilly, C.E., in the chair.—Notes on the energy of the Ischia earthquakes of 1881 and 1883, by Rev. Dr. Haughton, F.R.S.—Dr. Haughton also communicated an extract from a letter from a lady in India, respecting the fall of a meteoric stone at Roorkee.—Note on *Edwardsia timida* (Quatr.), by G. T. Dixon, M.A. The specimen was found at Malahide, Co. Dublin. This is the first record of the occurrence of this species in the British Isles.

SYDNEY

Linnean Society of New South Wales, November 25, 1885.—W. J. Stephens, F.G.S., President, in the chair.—The following papers were read:—A list of the Trogositidæ of Australia, with notes and descriptions of new species, by A. Sidney Olliff, F.E.S., Assistant Zoologist, Australian Museum.—Notes from the Australian Museum—a new butterfly of the family Lycænidæ, from the Blue Mountains, by A. Sidney Olliff, F.E.S., Assistant Zoologist, Australian Museum.—On a remarkable fish, from Lord Howe Island, by William Macleay, F.L.S., &c. Under the name of *Ctenodax wilkinsoni*, Mr. Macleay described a fish picked up on the beach at Lord Howe Island, and made some remarks on its probable affinities. He considers it not referable to any known family.—Recent changes in the forest flora of the interior of New South Wales, by R. von Lendenfeld, Ph.D. Based on observations made by Mr. Forest Ranger Ridston and others, and on his own experience in the Nymagee-Condobolin district, the author gives an account of the rapid spreading of the pine (*Frenela robusta*) within the last twenty years. A table giving averages of the rainfall, the spread of the pine and of the beetle *Diodoxus erythrurus*, White, which in its larval stage destroys the young pine-trees, accompanies the paper.—The Australian freshwater Rhizopods, Part I., by R. von Lendenfeld, Ph.D. This paper is the first of an intended series in which the Australian Protozoa belonging to the groups Rhizopoda and Heliozoa are to be registered, and the new species described. In this paper six species are mentioned, two are new. It is a most remarkable fact that the common and well-known European forms are all apparently found in equal abundance in Australian waters. The new species are very similar to European ones, and do not present any marked peculiarities. It does not appear likely that there were no Rhizopods in Australian creeks before the advent of Europeans, and so it cannot be assumed that all these Australian species have been imported. As they cannot travel over the oceans dividing Australia from other continents, it must be assumed that they are unchanged descendants of the Rhizopods of that geological period, in which Australia was not isolated. The absence of forms peculiar to Australia speaks strongly against any recent spontaneous generation.—An Alga forming a pseudomorph of a siliceous sponge, by R. von Lendenfeld, Ph.D.—*Onchidium chameleon*, sp. nov., and the structure of the dorsal skin of this and other Onchidia, by R. von Lendenfeld, Ph.D., and John Brazier, C.M.Z.S.—Observations on some Australian Polychæta, by W. A. Haswell, M.A., B.Sc., &c.—Descriptions of two new fishes from Port Jackson, by E. P. Ramsay, F.R.S.E., &c., and J. Douglas-Ogilby, Australian Museum.—On some remarkable crystals of siderite, by F. Ratte, Eng., Arts and Manufactures (Paris).

PARIS

Academy of Sciences, February 8.—M. Jurien de la Gravière, President, in the chair.—Discourses on the occasion of unveiling the statue erected in front of the Collège de France to the memory of Claude Bernard, on February 4, by MM. Paul Bert, Berthelot, Fremy, and Chauveau. The statue, which is cast in bronze, is the work of M. Guillaume, Member of the Institute.—Farewell address of M. Paul Bert on his departure to Tonquin, where he has recently been appointed Civil Administrator. In the course of his remarks the speaker expressed a hope that the young naturalists of the West would begin to turn their attention to the Far East, and teach the learned classes of those regions more fully to appreciate the superiority of European science. "I rely on them," he added, "to increase our moral influence, and also to enlarge our knowledge of that region, in many places still unexplored, to study its resources, and prepare the way for the introduction of the great European industries. They will thus at once promote the interests of science and of France, a task enviable beyond all others."—Remarks on the celebration of the centenary of Arago's birth, on February 26th prox., by M. Mouchez. It was stated by the speaker that the celebration would take the form of a public ceremony in the presence of the various deputations, during which would be crowned the bust of Arago, occupying the site on the Boulevard Arago, where a monumental statue is subsequently to be raised to the great astronomer by public subscription. The proceedings will close with a subscription banquet at the Hôtel de Ville, to which will be invited the members of the Arago family.—Note on celestial photography, by M. Mouchez. Amongst the stellar photographs already obtained at the Paris Observatory, was one of the nebula near the star Maia in the Pleiades, which had never before been seen with the best glasses. But M. Struve now telegraphs to the author that he has just detected this nebula with the new large equatorial of 0·80 m., recently set up in the Pulkova Observatory. It was added that Dom Pedro, Emperor of Brazil, had instructed M. Cruls, Director of the Rio de Janeiro Observatory, to prepare a photographic apparatus similar to that now in use in Paris, for the purpose of co-operating in the general project of photographing the starry regions, already begun with such unexpected success at the Paris Observatory.—Determination of the elements of refraction, two diagrams, by M. Lœwy. It is shown that, in spite of all the rotatory movements of the double mirror, the fundamental condition for determining the constant of refraction is always fulfilled. This principle rests on the geometrical property that the projection of the distance of two images on the trace of the plane of reflection remains invariable and always equal to the distance $r'\rho'$ relative to the epoch when the two stars and their two reflected images are found comprised in the same plane.—On some hyperelliptical formulas, by M. Brioschi.—Note on the first botanical collections that have reached the Paris Natural History Museum from Tonquin, by M. Ed. Bureau. This first collection, carefully prepared by M. Balansa, is confined exclusively to the neighbourhood of Hai-Phong and of Quang-Yen; but it gives a complete picture of the flora of these districts.—Remarks on the admission of patients suffering from pulmonary tuberculosis into the public hospitals, with a view of determining how far this disease is contagious, by M. E. Leudet. The elements that have served to offer a solution of this question are the records of 16,094 adult patients of both sexes treated in one of the wards of the Rouen Hôtel-Dieu during the thirty-one years from 1854 to 1885. The author concludes that the propagation of pulmonary tuberculosis by contagion in hospitals has not been demonstrated, or that it is at least very restricted.—Observations on Fabry's comet made at the equatorials of the Bordeaux Observatory, by MM. G. Rayet and Courty.—Equatorial observations on Barnard's comet, made at the Bordeaux Observatory, by M. F. Courty.—Observation of Brooks's comet made with the 14-inch equatorial of the Bordeaux Observatory, by MM. G. Rayet and Courty.—On the shower of shooting-stars observed on November 27, 1885, at the Zi-ka-wei Observatory near Shanghai, China, by Père Marc Dechevrens. The meteoric display is described as less imposing than that of November 27, 1872. The stars appear to have swept by at the rate of about a hundred every 15 minutes. Notwithstanding the moonlight a few were still seen so late as 4 a.m. the following morning—On a new system of projection of the sphere suggested by an inquiry into the means of representing the elliptical functions geometrically, by M. Guyon.—Note on Ivory's theorem and on some theorems in connection with the homofocal surfaces of the second order, by M. A. Mannheim.—Researches on the groups of finite order contained in the group of the linear substitutions of contact, by M. Autonne.—Note on a new process for

preparing orthophosphoric acid, and the titration of phosphoric and arsenic acids by means of various indicators, by M. A. Joly.—Note on the action of acetic acid on the essence of turpentine, by MM. G. Bouchardat and J. Lafont. It is shown that acetic acid combines already in the cool state with the essence of turpentine, yielding monacetates belonging to two entirely distinct series. At the same time the uncombined essence is transformed into two carburets $C_{20}H_{16}$, one monovalent, analogous to terebinthene, the other bivalent, or active terpilene.—Note on a new direct method of studying animal heat, by M. Desplats. The method here described is carried out by means of M. Berthelot's water calorimeter, but it is applicable only to small animals, such as rats, guinea-pigs, sparrows, &c. At equal weight and in a given time birds are found to evolve three times more heat than mammals, absorbing thrice the quantity of oxygen and emitting three times more carbonic acid.—Note on the Eocene Echinidæ belonging to the family of the Spantangideæ, by M. G. Cotteau.—On some fossil Cycadeæ of the Carboniferous formations, by M. Daubrée.—On a sub-lacustrine moraine on the bar of Yvoise, which divides Lake Geneva into two distinct basins, by M. F. A. Forel. The dredgings carried out in September 1885 have satisfied the author that this bar is, in fact, a glacial moraine like the neighbouring hills. That this moraine, 60 metres below the surface and 1 kilometre from the shore, has been kept clear of recent lacustrine alluvial deposits, is attributed to the action of the sub-lacustrine currents.—Remarks on the geological map of Russian Turkestan prepared by MM. Mushketoff and Romanovsky—six chromolithographic sheets to the scale of 1 : 1,260,000, by M. Venukoff.—Note on the relations existing between the geological, topographic, and chemical properties of the soil and the vegetation covering it in Central Russia, by M. Venukoff.

BERLIN

Meteorological Society, December 1, 1885.—Prof. Börnstein reported on a treatise by Herr van Bebber, which had just appeared, in which the latter, on the ground that typical weather phenomena accompanied the minima that advanced along the well-known highways of storms over Europe, demonstrated that, from the position of the minimum on one of the five highways of storms, and from the local condition of the weather, might be derived the best data as a basis for a trustworthy prognostication of the weather.—Prof. Schwalbe made a comprehensive survey of the investigations that had been carried on by him for several years respecting the ice cavities. In supplement of former reports on these investigations (*vide* NATURE, January 28, p. 312) the following is abstracted from the address which dealt at large with the subject. The earliest notice of the occurrence of ice cavities was contained in an account written in the end of the seventeenth century. In the last and in the beginning of the present century ice cavities had been variously described, but the descriptions were greatly exaggerated. Down even to the present time these enigmas of nature were little known and little investigated. Of all students of natural science whom this subject had engaged, the speaker had assuredly examined the greatest number of ice cavities. Ice cavities formed but one group of ice phenomena, which comprehended likewise dolines, ice holes, rolled ice, ventaroles, and the cold strata of the ground. In the temperate zone they were pretty widely distributed, and occurred in the most varied mountain systems of Europe at heights of from 2000 to 4000 metres above sea-level, and some individual ones at much lower elevations. They were found principally in limestone, in gypsum, in basalt, and lava, but were present likewise in mica slate and other stones. The most essential condition of their presence was that the stone should be readily percolable by water. In the majority of cases the entrance into these cavities was from above, and the passage was directed downwards, yet there were also cases in which the entrance was from below and the passage upwards. The cavities themselves were completely isolated, and no draught of wind was ever perceived in them. The air in the cavities was in winter somewhat colder than in summer, in winter the temperature sinking to 0° C., and somewhat lower, in summer ranging from 4° to 5° C. The walls were always colder than the air in the central part, and the air, moreover, was always completely saturated with moisture. The ice is formed in spring, when the water began to filter through the ground, and almost exclusively on the floor of the cavities. The ceiling was always free of ice, the floor more or less uniformly covered with a thick layer of ice, which, on being broken, splits into prismatic pillars resembling honeycombs. The walls were covered with pearl-like ice-crystals, and stalactitic ice formations came multifariously to view. There was frequent opportunity for observing in an ice cavity how the water-drops, having filtered through the stone, fell to the ground, and there at once congealed. The speaker then referred to and combated the various theories which had been brought forward to explain the ice formation in the cavities. His own view was that the water filtering through the cold stone became refrigerated to excess, and therefore, on falling, at once congealed.

BOOKS AND PAMPHLETS RECEIVED

"Report of the Meteorological Council to the Royal Society for the Year ending March 31, 1885."—"Jubilee Volume of the Statistical Society" (Stanford).—"British Petrography," Part I.: J. J. H. Teall (Watson, Bros., and Douglas, Birmingham).—"Register zu den Bänden 86 bis 90 der Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften" XI. (Gerold's Sohn, Wien).—"Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften; Mathematisch-Naturwissenschaftliche Classe:—Zoologie, Geologie, und Paläontologie," June and July, October to December, 1884, January to April, 1885. Ditto, "Mathematik, Physik, Chemie, Mechanik, Meteorologie, und Astronomie," June and July, October to December, 1884, January to March, 1885. Ditto, Physiologie, Anatomie, und theoretischen Medicin," March to July, October to December, 1884; January and February, 1885 (Gerold's Sohn, Wien).—"Contributions to Canadian Palæontology,' vol. i. part 1: J. F. Whiteaves (Dawson, Bros., Montreal).—"Report of the Meteorological Service of the Dominion of Canada for the Year ending December 31, 1883": C. Carpmael (MacLean and Co., Ottawa).—"Common-Sense Euclid": A. D. Capel (J. Hughes).—"Poultry for Prizes and Profit," parts 4 and 5: J. Long (L. U. Gill)—"British Cage-Birds," parts 5 and 6: R. L. Wallace (L. U. Gill).—"Bees and Bee-keeping," parts 5 and 6: F. R. Cheshire (L. U. Gill).—"Book of the Goat," parts 5 and 6: H. S. H. Pegler (L. U. Gill).—"Fancy Pigeons," parts 5 and 6: J. C. Lyell (L. U. Gill).—"Why we do not adopt the French Metrical System in place of our Anglo-Saxon Metrology": C. Giles (Banks and Son).

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